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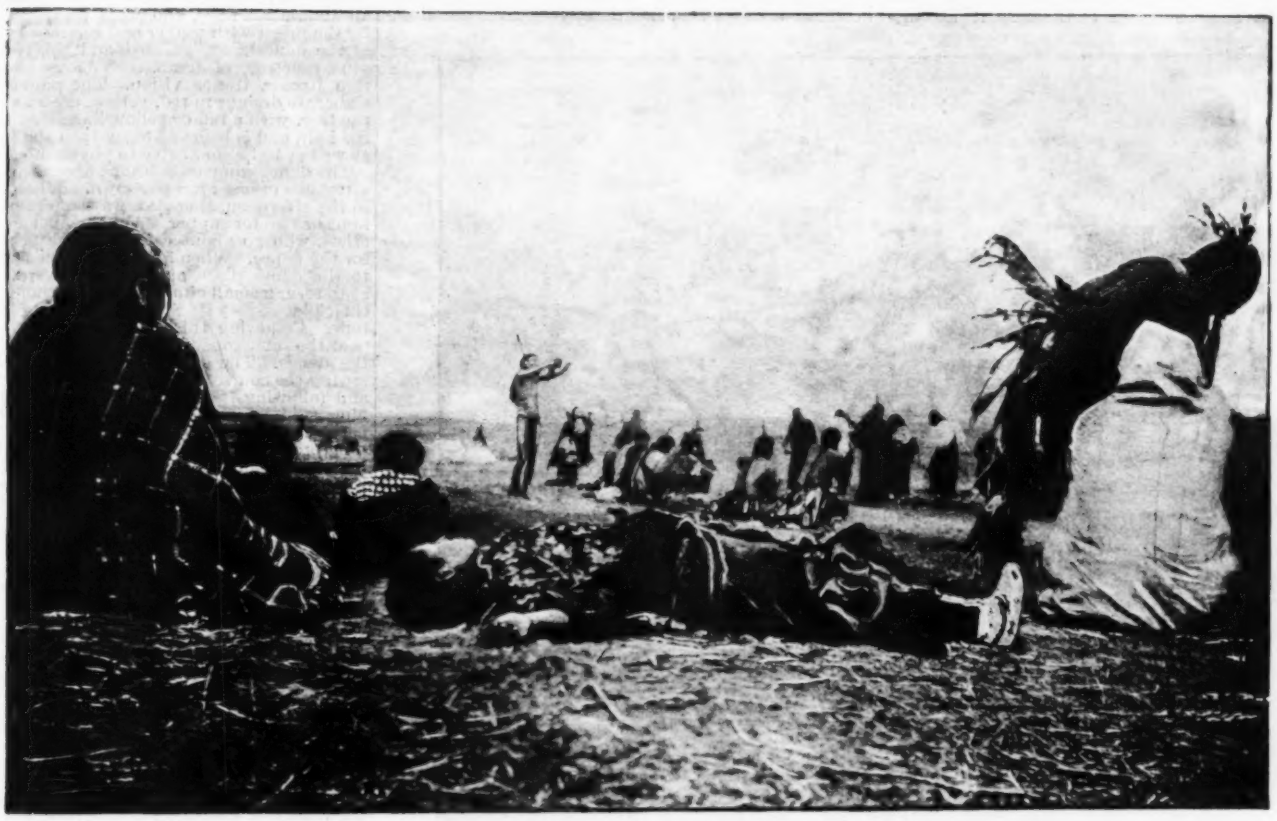


THE GHOST DANCE—UNCONSCIOUS.

THE GHOST DANCE—RIGID.

GHOST DANCE.—II.*

The underlying principle of the Ghost Dance doctrine is, that the time will come when the whole Indian race, living and dead, will be reunited upon a regenerated earth, to live a life of happiness forever, free from death, disease, and misery. On this foundation each tribe has built a structure from its own mythology, and each apostle has filled in the details according to his own idea of happiness, with such additions as come to him from the trance. The white race, which is alien and secondary, has no part in this scheme of regeneration, and will be left behind or will cease to exist together with the other things which have served their temporary purpose. Different dates were assigned, at various times, for the fulfillment of the prophecy, and, prior to the Sioux outbreak, the date commonly accepted was August, 1891; but, as the prophecy failed to materialize, it gradually assumed the form that some time in the unknown future all the Indians, dead and living, would be reunited and would be forever after supremely happy, and that the happiness might be anticipated in dreams, if not actually hastened in reality by earnest and frequent attendance on the sacred dance.

BLACK COYOTE.

It will be recalled that the Sioux outbreak of 1890, which culminated in the battle of Wounded Knee, was generally attributed to the Ghost Dance religion. This was a mistake. It has been proved beyond doubt that the trouble had its origin in a long list of grievances, for which Congress was largely responsible, prominent among them, a failure to supply food according to treaty requirements; but the Ghost Dance did play an important part in focusing and directing the action of the Indians. Short Bull and other Sioux delegates had gone to pay a visit to the Messiah, late in 1889, and returned in March, 1890. He at once began to preach the new doctrine, but was stopped by the agent. Nevertheless, the infection spread rapidly, although quietly, through the greater part of the tribe. The excitement was greatest at the Pine Ridge Agency, where there were 6,000 of the wildest and most warlike of the Sioux under the influence of the celebrated chief Red Cloud, and on the Rosebud reservation, which adjoins on the east, the Ghost Dance was in full swing in September of that year, under the leadership of Short Bull, notwithstanding strenuous efforts by Agent Wright to suppress it. On October 9 Kicking Bear, the chief high priest of the Ghost Dance among the Sioux, went to Standing Rock by invitation of Sitting Bull, and inaugurated the dance on that reservation. The agents reported that it was impossible to stop the dance without military aid, and repeatedly asked for troops, which, about the middle of November, were ordered out in force. Upon their arrival the disaffected Indians, to the number of about 700, under the leadership of the chief malcontents, Short Bull and Kicking Bear, withdrew to the Bad Lands, and there awaited developments, in the meantime continuing the performance of the Ghost Dance, which had been practically suppressed at the agencies, except at the camp of Sitting Bull, the irreconcilable.

Fighting was precipitated by an attempt on the part of the native police to arrest Sitting Bull on orders from the authorities. Sitting Bull and several of the police were killed, but the opportune arrival of troops prevented an outbreak by his followers, and the hostiles out in the Bad Lands received no material accession from them. A few days later some of the refugees attacked a wagon train, and desultory fighting continued through the month. Successful efforts were made to bring in the refugees in small bands, one at a time. On the evening of December 29, 1890, the Indians were collected near the agency for the purpose of being disarmed, and the process had actually been begun by the troops going through the tepees looking for rifles, when the tension under which the Indians were laboring became too great, and one of them fired on the soldiers, who surrounded them on all sides. A volley was instantly directed into the crowd of warriors and a desperate hand to hand fight ensued. Nearly every one of the warriors wore a sacred "ghost shirt," which he believed rendered him invulnerable, but in a few minutes 200 Indian men, women, and children and 60 soldiers were lying dead and wounded upon the ground, while the handful of surviving Indians fled to the shelter of a neighboring ravine pursued by hundreds of maddened soldiers and raked by the fire of machine guns trained upon them. The flight was simply a massacre. The Indians who had come in to surrender to the number of 4,000 or more, hearing the firing, fled back to the Bad Lands, and desultory fighting continued for two weeks, but the hostiles all finally surrendered to Gen. Miles on January 16, 1891, and the outbreak ended.

The "ghost shirt," which came into prominent notice at the battle of Wounded Knee, is perhaps the most important feature of the dance among the Sioux. On account of the scarcity of buckskin, these shirts are always made of white cloth, cut and figured in the Indian fashion. It was supposed to confer invulnerability. The dance itself is an elaborate ceremonial, usually preceded by extensive preparations and repeated rehearsals of the songs to be used. Generally the dance ground was consecrated before the performance, one of the leaders going all about the place, sprinkling sacred powder over the ground, and praying the while. The official ordination of the priests in the dance consists of the ceremony of "giving the feather," which is presented to seven leaders, or sometimes to fourteen (seven men and seven women), the number seven being especially sacred in the Ghost Dance. The feathers, which were worn upon the heads of the dancers, were either those of the crow, the sacred bird of the dance, or of the eagle, sacred in all Indian religions, and were previously consecrated by the priest with prayer and ceremonies. The bodies of the dancers are painted, and this is done with the same exactness of detail, each design being an inspiration from a trance vision. The painting consists of elaborate designs in red, yellow, green, and blue upon the face, with a red or yellow line along the parting of the hair, and is believed to sharpen the spiritual vision as well as to be conducive to physical health.

The dance commonly begins about the middle of the afternoon or else after sundown. When it takes place in the afternoon, there is always an intermission of an hour or two for supper. An announcement is made by criers, who go about calling to the people to prepare for the dance. When all is ready, the leaders walk out to the dance place, and, facing inward, join hands so as to form a small circle. Then, without moving from their places, they sing the opening song in a low undertone. Following this, they raise their voices and repeat the same song, this time slowly circling around in the dance. The dancers move from right to left, following the course of the sun, advancing the left foot and following it with the right, with a peculiar shuffling step, which has caused some of the tribes to name the ceremony "the dragging dance." As the song proceeds, the people come out from the tepees, or huts, and join the circle until from 50 to 500 men, women, and children are in the dance. When the circle is small, each song is repeated a number of times; if large, each song is continued through one circuit, measured by the return of the leaders to the starting point. Each song is given in the same manner; first in an undertone, while the dancers remain in their places, and then in full voice as they circle around. At intervals between songs the dancers unclasp hands and sit down to smoke and talk a few minutes, and at these times the leaders sometimes deliver short sermons or relate recent trance experiences.

No drum, rattle, or other musical instrument is used, and in this respect the Ghost Dance differs from all other Indian dances. Usually the dance is performed around a tree or pole planted in the center of the circle and variously decorated. As the dance proceeds, the most intense excitement takes possession of the performers. They move as fast as they can, their hands moving from side to side, their bodies swaying, and the weak and frail are jerked up into position until exhausted nature at last gives way and one after another the performers break from the ring, stagger away and fall down. No one ever disturbed those who fell or took any notice of them except to keep the crowd away. This was continued until a considerable number had fallen out, when those remaining stop, and seat themselves in a circle, where they wait until the dancers revive, when each one relates his or her experience while in the trance. In other and more elaborate dances the trance condition is aided if not produced by the medicine man through an actual hypnotic process.

As the performers become frenzied and stagger about the ring, they attract the attention of the medicine man, who stands in the center, holding in his hand an eagle feather or a piece of cloth. Usually it is the women who are first affected. Selecting one of these, the medicine man goes over to her and stands immediately in front of her, looking intently into her face, and whirling the eagle feather or cloth, or both, rapidly in front of her eyes, moving slowly around with the dancers, but always facing the woman. During all the time, he keeps up a series of sharp exclamations, "Hu! Hu! Hu!" like the breathing of an exhausted runner. In a short time the woman loses control of herself entirely, and breaking away from her partners she staggers into the ring, while the circle closes up at once behind her. The medicine man gives his whole attention to her, and continues his motions until the subject becomes rigid, with her eyes shut or fixed and staring, and at last falls to the ground motionless. The song and dance never stop, and as soon as the woman falls, the medicine man gives his attention to another subject, and so on to the end of the dance.

Not every leader in the Ghost Dance is able to bring about the hypnotic sleep, but anyone may try who feels inspired. Any man or woman who has been in a trance can go within the circle and endeavor to bring others to that condition. The hypnotist is believed to be the passive instrument of a higher power, and even when the result is unsatisfactory, there is no interference with the performer. There is usually much humbug mixed up with the performance, some pretending to be under the influence in order to attract the attention of the crowd, but the greater number are unquestionably genuine cases of hypnotism. Frequently a number of persons are within the ring at one time, in all the various stages of hypnotism, and the proportion of women affected is usually three times that of the men. Sitting Bull was especially skillful at this work, and has been known to have one hundred subjects stretched out in the circle at one time. It was he who introduced the trance into the Ghost Dance.

A somewhat related ceremony is the prayer, not performed in connection with the dance, but usually as a separate affair. The ceremony is thus described by Mr. Mooney, who was subjected to it:

"On entering the room the Indian priest approached and performed mystic passes in front of my face with his hands, . . . blowing upon me the while, as he

* Specially prepared for the Scientific American Supplement by Cosmos Mindeleff.

afterward explained, to blow evil things away from me. . . . Laying one hand on my head, and grasping my own hand with the other, he prayed silently for some time with bowed head, and then lifting his hand from my head, he passed it over my face, down my shoulder and arm to the hand, which he grasped and pressed lightly, and then released the fingers with a graceful upward sweep, as in the minuet." The next day twenty or more Indians came to see him, and on entering the room the whole company went through the same ceremony with each one of the inmates in turn, the whole being done without a word being spoken. It is in fact a religious greeting as much as a prayer.—For our engravings we are indebted to the courtesy of the Director of the Bureau of Ethnology, Smithsonian Institution. They are from the Fourteenth Annual Report of the Bureau of Ethnology.

LONICERA HILDEBRANDIANA.

ALTHOUGH our gardens are already well supplied with numerous species of Lonicera, some being very handsome shrubs, there is none among them that will at all compare in size of flower with the present novelty, for it is by far the finest species that has yet been introduced into cultivation, and may easily claim to be the prince of honeysuckles. This grand shrub flowered in August with Mr. F. W. Moore in the Botanic Garden at Glasnevin, Dublin, probably for the first time in cultivation, and just about ten years after its discovery. As may be seen from our illustration, it is

LONICERA HILDEBRANDIANA—COLOR OF THE FLOWERS BRILLIANT ORANGE-SCARLET.

the giant of the genus, its flowers being larger than those of any other known species, and as they are of a brilliant orange-scarlet, they make a fine display. Lonicera Hildebrandiana is a native of the Shan Hills, where it was discovered by Sir H. Collett in 1888, growing at 5,000 feet elevation, and probably requires the temperature of an intermediate house for its successful cultivation. The leaves are stalked, 3½ to 5 inches long, 2 to 3½ inches broad, ovate or elliptic-ovate in outline, rather abruptly and obtusely pointed at the apex, rounded at the base, and quite glabrous. The flowers are produced in pairs on short peduncles, in the axils of the leaves. The calyx is about one-third of an inch long and shortly five-toothed. The brilliant flame-colored corolla is about 5 to 6 inches long, and is said to attain a length of 7 inches, the lips measuring 2¼ to 2½ inches. We are indebted to The Gardeners' Chronicle for the engraving and description.

DATE INDUSTRY IN PERSIA.

ONE of the most interesting, profitable, and growing industries in Persia is date farming, says Alex. McDonald, United States consul at Teheran. The date palm is indigenous in the south, and its cultivation is confined to a tract running parallel to the Persian Gulf from the borders of Beloochistan on the east to the Disful River on the west, and extending about 150 miles into the interior. Palm groves, however, by no means absorb the whole of this area. They are chiefly confined to sheltered valleys and plains exposed to a high temperature in the summer and having a very mild climate in winter. The palm requires a great degree of heat for the ripening and perfecting of its fruit, and is, consequently, considering the size of the trunk, extremely sensitive to cold. This arises chiefly from the fact that the vital portion, or that which is most easily affected by outward influences, is the crown or head of the tree. If this be severed or frost-bitten, decay immediately sets in and the plant dies. On this account, it is often considered the connecting link between the vegetable and the animal kingdoms, and those who cultivate it and depend upon it for support look upon it with a large degree of veneration and respect.

With the most favorable conditions for growth, the plant will not bear fruit under from eight to ten years. It attains a height of 50 to 60 feet and lives upward of a hundred years. If, on the contrary, the influences of climate and soil are not suitable, it will produce fruit in four years; but the life of the tree will not be prolonged beyond twenty years, and the fruit is of an inferior quality.

The chief requisite for the production of fruitful and profitable palms is a high degree of temperature in the summer—not less than 110° F. in the shade. The water and soil should, if possible, show a low percentage of saline and alkaline qualities, or to use the local term, they should be "sweet." As rain seldom falls in the southern littoral of the Persian Gulf between April and December, the palms are supplied with moisture by irrigation; and where this cannot be provided, the cultivation cannot be undertaken—that is, so far as the Persian area is concerned.

It is reported that the date palm will not flourish within a distance of 25 miles from the sea. If this is the fact, it is probably owing to the impregnation of the atmosphere and the soil with an excessive percentage of salt; and this would seem to be in accord with the general principles observed in the selection of sites for the groves. A very important point observed in the cultivation of the groves is to have a proper proportion of male and female palms, for unless there be sufficient pollen for the process of fertilization the plants will be unproductive. It appears from this that some technical knowledge is required for the successful management of the groves.

The production of the Persian palms is about 500,000 cwt. per year, nearly half of which is exported to India, Europe, America, and Africa. The customs valuation is about 85 cents per cwt. The dates produced in Persia and shipped from the gulf ports are hardly equal in size, flavor, and richness to those exported from Bassorah. This is doubtless due to more careful cultivation by the Arabian and Turkish producers.

In addition to the consumption of the dates in their raw state by the natives, considerable quantities are used in the manufacture of sirup, vinegar, and a liquor called "arrack," none of which are, so far as I know, articles of exportation.

There can be no doubt that, if conditions of climate, soil, and water suited to the growth of the palm could be found in the Southern or Southwestern States, a very useful and profitable industry might be introduced for the benefit of the American people.

THE ELAMITE SUSA FOUND.

NEWS has recently been received in Paris of Mr. G. De Morgan's scientific mission in Persia. The results seem to have been highly satisfactory. The exploring party began operations last fall, reaching the ancient province of Susiana in December. Since that time work has been concentrated on the site of the ancient Susa, and the explorer has, with his customary skill and good luck, brought to light what must be considered the ruins of the ancient capital of the Elamite kingdom, one of the most powerful Asiatic monarchies at a period that takes us back to the dawn of civilization.

At the time of his first journey of exploration in Persia, Mr. De Morgan paid special attention to a study of the site of Susa. From August 27 until October 10, 1890, he explored Susiana and remained camping on the ruins of Susa from September 11 to September 16. At this time the French government had not obtained the exclusive privilege to dig in the Shah's dominion, and excavations were strictly prohibited by the Persian authorities; so the explorer had to content himself with a thorough inspection of the surface.

The Susiana of antiquity is now part of the modern Persian provinces of Arabistan and Khouzistan. It lies between the slopes of the Louristan Mountains on the northeast and southeast, the extremity of the Pouch-é-Kouh range on the northwest, and the swamps of Samirda on the west. The Persian Gulf forms the southern limit. The Elam includes two parts entirely different—the mountainous part, which is almost inaccessible and cut by deep cañons like those of Colorado, and the lowland or Susiana, an immense alluvial plain formed by the deposits of the four great rivers of Louristan, the Kherkha, the Ab-é-Diz, the Karoun, and the Djerrahi. This process of filling in has been going on unceasingly for centuries, and the Persian Gulf shore has been brought much forward, so that the ancient settlements must be looked for quite a distance inland from the present shore. In the plains of Susiana they are marked by large mounds made of rubbish and débris left by successive civilizations. In these plains there is no stone or rock suitable for building, and the material used most generally was sun-dried bricks, which, during the rainy season, were easily melted into shapeless mounds, embedding in their crumbling mass what was left of previous civilizations. Of such is the artificial hill where stood Susa. In these heaps of rubbish the winter rain has cut deep ravines, and it is by the examination of these natural excavations that Mr. De Morgan convinced himself of the presence of remains of successive civilizations, all well stratified.

"The examination of the principal mound of Susa," writes Mr. De Morgan, "that one on which stood the acropolis, and where certainly were erected the oldest buildings, disclosed many scientific treasures. At the top are the débris left at the beginning of our era or during the mediæval ages, by the Araba, the Sassanids, and possibly the Parthians; below you come across the ruins of the Achæmenian epoch, the crumblings of which cover a thickness of some seven or eight inches. These beds are full of broken bricks or glazed pottery. It is below this mass of débris, the oldest dating back to the Achæmenian epoch, that are found the Elamite remains. These are found in a thick bed of earth, ashes, and débris of all kinds, the date of which is easily discernible by the nature of the ceramics that they contain. The Elamite pottery, the fragments of which are very abundant in all the mounds of Elam, is particularly interesting. At Susa the paste is sometimes coarse, or very fine, made with the wheel, and sometimes very light. The most elaborate vases are ornamented with geometric patterns, painted in brown, white or red, on a yellow or reddish ground. This pottery indicates on the part of the potters who made it a great amount of practical knowledge and skill. On the same level, and mixed with the fragments of pottery, are found at Susa fragments of alabaster, vases in hard stone similar to those of Egypt, and pieces of statues, some of them bearing inscriptions in Susian.

"Below the Susian débris are remains which I will designate as prehistoric, because there are in this level cut flints, nuclei, knives, splinters, blades, and coarse pottery hand made without use of the wheel. This stratum may have a thickness of ten to twelve meters in the largest mound of Susa."

There was, then, no doubt in Mr. De Morgan's mind that, in order to discover the successive remains, the only thing necessary was to dig at various levels. The conditions were the same as those observed by Schliemann at Hissarlik. When Mr. Dieulafoy made his excavations at Susa he left unnoticed anything that was not Achæmenian, reserving all his activity for the upper part of the mound. The result of his excavations was highly interesting, but still he had unfolded only one page of the book he had before his eyes. During his short stay at Susa Mr. De Morgan understood at once the importance of that ground, and, seeing what had been done, realized what remained to be accomplished. It was the reading of a few lines from Herodotus that decided Mr. De Morgan to select Dashur, in preference to many other spots, as the main site of his excavations in Egypt, which resulted in the splendid discoveries recorded by The Sun at the time of the finds. The reason that decided him to work at Susa was an inscription of Assurbanipal, in which the Assyrian conqueror relates his capture of the capital of Elam. The French scholar, Mr. G. Menant, gives the following translation of this document:

"I resumed," says Assurbanipal, "my victorious march through the country of Elam. . . . I captured the great city of Susan, the site of their great deities, the sanctuary of oracles. By the will of Assur and Istar I entered into his [the king's] palaces, and there rested with pride. I opened their treasures, I took silver, gold, treasures, their wealth. All the belongings which the first king of Elam and the kings that succeeded him had gathered, and on which no enemy had ever laid his hands, I captured as a booty." Here comes a long descriptive list of all the objects captured, and the king continues: "I have destroyed the tower of the city of Susan, with its marble base. I upset its summit, which was covered with brilliant brass. . . . I carried away Susinak, the god of their oracles, which dwelt in the forest, and whose

divine image nobody had ever seen. . . . I sent all these gods and goddesses, their treasures, their apparel, priests, and worshipers, to the country of Assur, thirty-two statues of kings, in silver, gold, bronze, marble, coming from the cities of Susan, Madatu, and Huradi. . . . I carried everything to the country of Assur. I smashed the winged lions and the bull which stood as guards of the temples. I upset the winged bull which stood by the doors of the country of Elam's palaces, and which so far had never been touched."

It is impossible to give in extenso this long record of devastation which contains details of the most horrible atrocities. As the conqueror states that after one month and one day of destruction all through the land of Elam, he returned to his kingdom, "leaving Susa to the wild animal of the desert, to the snakes and to the gazelles," it is to be concluded that he left behind him real historical treasures in the shape of these mutilated monuments which have since 645 B. C. lain there buried in the desert waiting for a discoverer. Such was Mr. De Morgan's conclusion from reading Assurbanipal's annals.

Last winter was entirely devoted to organization. This work was accomplished amid the greatest difficulties. In this barren, alluvial plain everything has to be brought from a long distance, wood building material, provisions of all sorts, and this in spite of a nomad population always on the lookout for chances to commit highway robbery. Still, Mr. De Morgan has succeeded in building a shelter for his party, and excavations have been so far advanced that the palaces of the ancient capital of Elam have been brought to light. To be sure, no precious metal of any kind has been found, but many inscriptions have been discovered. They are on bricks, or engraved on stone of various kinds. One of the most important is engraved on a large granite obelisk. The text is written in very archaic cuneiform characters, and is unquestionably, from the style of the epigraphy, one of the oldest historical documents ever exhumed in Asia. There are also two small pyramids with bass reliefs and inscriptions, a large stele, and a bronze tablet. There are also many wall sculptures, the details of which will be given as soon as the text has been translated. This will very likely tax the skill of the best Orientalists, and will give them abundant material for discussion.

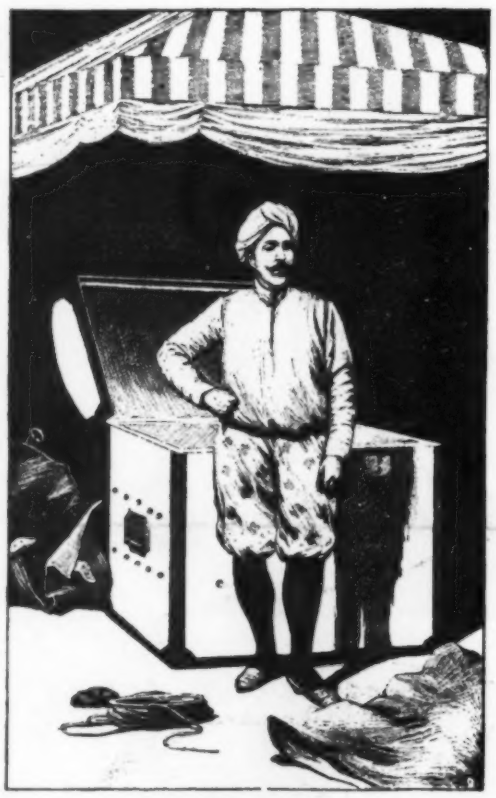
The last news received in Paris was dated at Susa on April 14. The hot season had already set in, and the work of excavation was about to be suspended until next fall, as no European could stand "the devil wind of the southwest," as the ancient Chaldeans used to call the wind of the desert. As it is, the Elamite Susa has been found. It remains now to gather what has escaped the destruction of Assurbanipal. Remembering what the same explorer has done in Egypt, the discovery of historical documents of the highest interest may be expected.—New York Sun.

THE TRUNK TRICK.*

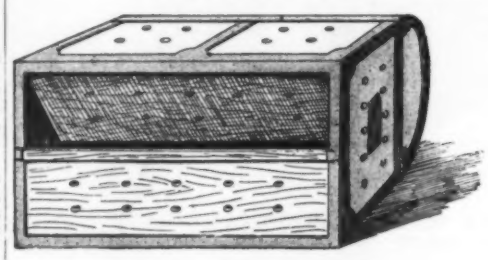
This trick, which attracted the attention of the world for months, is of English origin, and was presented in England long before it was introduced into Paris. The experiment consists of having a trunk examined, tying it, securing a cover over it, tying it a second time, sealing it with wax, and then showing that in a few seconds a young East Indian has succeeded in getting inside of it without unfastening the cords, breaking the seals, or opening the trunk.

Half the bottom of the trunk constitutes a trap door which is opened by inserting a round key in one of the ventilating apertures. As soon as the trunk has been tied, sealed, and placed under a canopy, the curtains of which are let down so as to hide the trunk from the spectators, the East Indian, who is also invisible to the spectators, lays the trunk down as shown in our second engraving, unbuckles the cover and slides it down, takes his key, opens the trap door, gets into the trunk, puts the cover in place, buckles it, and then closes the trap door. To raise the trunk to its proper position, he takes a long screw, something like a gimlet, from his pocket, inserts it in one of the holes under him, and turns it; the trunk rises slowly, and when it has reached its point of equilibrium, it falls back suddenly on its bottom. The noise thus made is the signal for the operator, who immediately draws back the curtains, finds by the weight that something is in the trunk, and then unties it slowly and presents the mysterious traveler to the audience.

It will be seen by one of our engravings that the Indian appears tied in a bag in the trunk. This is a variation of the trick. The bag is made of some light or soft material, and is provided with a hem at the mouth. In this hem runs a cord or tape; the performer draws the string tight, and seals the knots at the same time. The bag is then placed in the trunk, and the trunk is secured as above. The assistant who enters the trunk has concealed under his blouse a similar bag, the string of which is long enough to correspond in appearance to that of the other bag when it is tied and sealed. There are a couple of stitches missing on each side of the hem, leaving space enough for the assistant to insert his fingers. When he enters the trunk he removes this bag from his blouse, placing the original bag in the place of the duplicate. He now goes into the duplicate bag and places it up over his head, and, inserting his four fingers into the opening in the hem, draws in all the slack of the string, thus closing the bag, which is, of course, to all appearances, tied and sealed as the original.

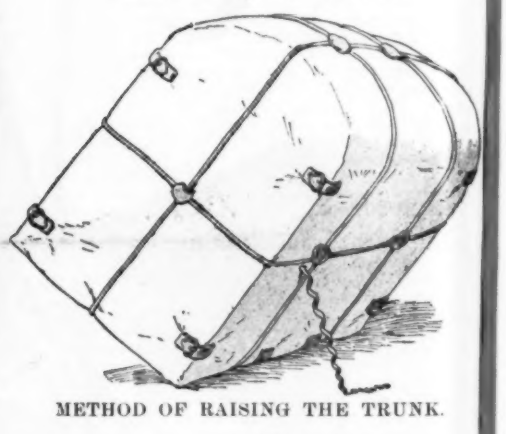


THE TRUNK TRICK.

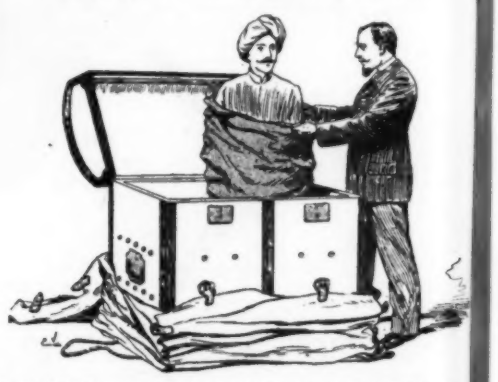


TRAP DOOR IN TRUNK.

PUTTING ON THE COVER.



METHOD OF RAISING THE TRUNK.



REMOVING THE BAG FROM THE INDIAN.

A TRAGEDY OF THE SEA.

It is a number of years since the group of coral keys known as the Dry Tortugas has seen so much activity as at present. During the civil war the central island, called Garden Key, was occupied by a large garrison, and had at times a population of 2,000 or more prisoners and soldiers. The latter belonged to the various regiments of artillery of the regular army, the First, Second, Third, Fourth, and Fifth, the Forty-seventh Pennsylvania, Seventh New Hampshire, and the famous "Billy" Wilson's Zouaves, who were sent there for a while and almost succeeded in taking command of the garrison, then in charge of a regular army officer.

The group consists of a number of islands, ranging from Garden Key, of thirteen acres, upon which is built one of the largest forts in the world, to East and Loggerhead Keys, several times as large. In formation they are essentially the same, being composed of ground shell and coral and a lime-secreting weed. This has been gradually piled up at different places, and, when well above water, bay cedars, cacti, and various vines and grasses have capped it with a green crest. Such are Loggerhead, Middle, Sand, Bird, Long, East, North, Bush, and Garden Keys on the outer Florida reef, collectively known as the Dry Tortugas, "Dry" because there is no fresh water there beyond the rain caught in barrels and cisterns, but very wet as regards sea water. Few of the keys are more than a foot or two above high water, and the writer has sailed about in the interior of Fort Jefferson on small lakes formed by water forced in and up by the storms. Salt water could be found almost anywhere by thrusting a cane down through the sand; hence the name "Dry" is a misnomer as applied to Tortugas.

The group of islands has always been attractive on account of the magnificent coral reef which constitutes the base upon which all the islands rest. It had a significance as being the only coral reef within the borders of the American continent or owned by this government, and has always been of interest to travelers and scientists who desired to study the conditions of life on a coral reef near at hand.

What may be termed the outer reef comprises an elevated platform, thirty or forty square miles in extent; the highest points being occupied by the keys described, and growing in an irregular atoll shape, with Garden Key in the center; long, slender Loggerhead to the west; East, Middle, and Sand Keys forming the barrier to the north, while Bush Key and a long, partly submerged barrier of dead coral rock, which will ultimately become an island, constitute the eastern front of this remarkable growth. The interior is cut by deep channels, the rich color of which presents a sharp contrast as they wind in and out—ribbons of azure, the blue veins of the reef. These channels constitute one of the mysteries of the reef, as they seem almost artificial; some being so deep and their walls so abrupt that it is possible to stand on the coral edge and dive directly down into blue water where it is eighty or more feet deep.

These channels have undoubtedly been worked out by currents and the sides covered with branch coral, which thrives in rough water. I once attempted to ascertain if this coral wall was perpendicular until it reached the bottom, and it was proposed to take a deep dive with a sinker and scrutinize it as far as possible. The boat was held four or five feet from the edge of the coral, and holding a thirty-pound rock by a rope, I let go and sank rapidly, holding on until as far from the surface as was thought wise, passing the millions of points all turned outward, like the bayonet points of an army.

The most noticeable feature of the drop was the change of temperature—first cold, then a warm current, and thirty or forty feet from the surface, where the sinker was dropped, the water was intensely cold. How much further down the coral continued could not be determined, but as far as it could be seen this wonderful growth was almost perpendicular, proving that here at least was an abrupt wall of coral.

What is known as the outer reef, a barrier of dead coral on the east, formed the outer edge of a fine grove of a short-branched coral which covered many acres, through which several years ago was a channel known as the "five-foot"—at that time the only channel through the breakers. The writer was made aware of its presence in a startling fashion. Out one day to the east in a sailboat, it began to blow, and the boatman said our only chance was to make the "five-foot," instead of going around to the main channel between East and Bush Keys; so he put the boat at what appeared to be an impenetrable wall of breakers. The nearer the boat approached, the more ominous was the outlook, as the jagged edges of coral rock were everywhere visible in the wash of the waves. But here the old boatman confided to me one of the secrets of the pilots of the reef, by which wrecker or pilot could rush in through the breakers, going on to what was apparently a certain wreck, but in reality an easy passage. He said it was merely a question of steering, as there was a channel fifteen or twenty feet wide and five feet deep which could be made by keeping the light on Garden Key on a line with the south chimney of the officers' quarters in the fort.

He handed me the helm, bidding me to keep it so while he trimmed the sail. When the point was reached where the sea began to break it was a most disagreeable sight.

A furious sea was breaking, and as it drew back the tremendous undertow dragged rocks from the reef with a frightful roar and rattle. A huge sea caught the boat, which went rushing on its crest to seeming destruction, then it broke, and she sailed in amid a sea of foam; but before another caught her the boat slid through the narrow entrance with but a few feet to spare, and the next sea sent her whirling into the calm water of the inner lagoon.

At various points there were large heads of brain coral. One group stood on the edge of the channel to the north of Garden Key; another on the opposite side; others again off to the northwest of Long Key, while some fine heads ornamented the channel near Bird Key, and fringed it to the west of Garden Key. Some of these heads must have weighed several thousand pounds. Many were hollowed out and were huge vases. Near the fringing reef were masses of leaf corals, while to the south small clumps of rose coral abounded; indeed, this reef was a veritable wonderland in the varieties of its coral life. It would have been an easy matter to make, in a few hours, a collection that would have ornamented any museum. Ships could have been loaded with it without making any impression on the supply, yet to-day it is almost impossible to find living coral on the Florida reef from Tortugas to Key West. A tragedy of the sea has occurred,

* Copyrighted, 1897, by Munn & Company.—From Magic: Stage Illusions and Scientific Diversions, including Trick Photography.

and these famous gardens of the reef, these tropical submarine forests, have disappeared as before the hand of the destroyer.

The coral reef of Tortugas is no more; that is, the living coral. The delicate polyps have succumbed to some enemy, and have died out, leaving only the base and bleaching ruins of what was once one of the finest coral reefs of the world.

That so remarkable a change could take place in an area nearly seventy miles in length seems incredible, but that this area was affected there can be no doubt. A letter recently received from an official on the island states that the destruction of coral is so complete that even a small collection could not be made. The cause of this destruction of an entire reef is unknown, though theories are not wanting. Some years ago the sudden death of fishes in this region was observed—fishes of all kinds succumbed, floated to the surface, and formed lines upon the shore. The fish were in good condition, and the cause of their death remained a mystery. A similar epidemic was observed among fishes off the Californian coast in 1894.

Tropical fishes are very susceptible to cold. The writer has seen weather so cold at tropical Tortugas that fires were acceptable, and it was cold work on the water; yet this did not affect the coral. In all probability, the cause can be traced to a submarine irruption, which permitted gas to escape over a wide area, destroying the growth. This, however, is not the last of the reef. In all probability, some polyps escaped, and the great masses of coral will again be covered with sand and mud and constitute the platform for myriads of other polyps, the eggs or young of which come drifting along in the Gulf Stream, swept up from other fields. These will attach themselves, and before many years the reef will blossom again with innumerable polyps.

In former years the growth of coral was supposed to be very slow, but branch coral is known to grow a foot in a year, and small heads of macandrina an inch or more a year.

The coral harbor of the Dry Tortugas, or Garden Key, is one of the most perfect small harbors to be found, the blue channel deep enough to float the largest ship ever built several times over, winding completely around the key. Its only fault is that it is too narrow for a large cruiser, and it would be impossible to turn. During the war the largest transports entered the harbor and came alongside the dock, passing out around the fort; and at one place, opposite the sally-ports, where a lateral channel cuts into the reef, there is room for a large vessel to swing.

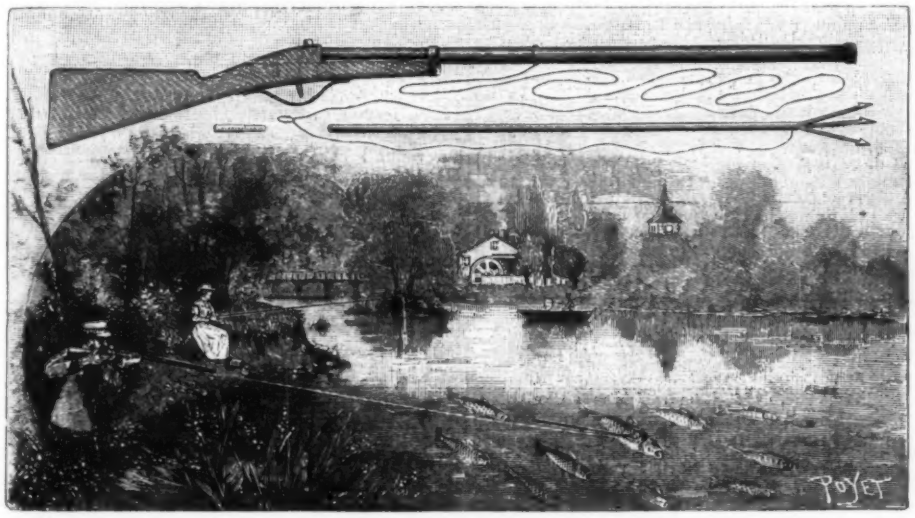
For years this port has been deserted, and everything has been allowed to go to ruin; but all this will be changed, and the key of the Gulf, the real Gibraltar of America, will again take its place among the important naval stations of the country.—C. F. Holder, in New York Evening Post.

A NEW FISHING GUN.

M. H. DONNET has recently devised a new fishing apparatus in the form of a gun having an iron barrel, and provided with a steel spring strong enough to throw a metallic three-pointed projectile, 38 inches in length, to a distance of 18 or 20 feet.

After firing his weapon and striking a fish, the operator has only to haul in the cord attached to the harpoon in order to land his victim.

For the illustration and description of the apparatus we are indebted to La Nature.



DONNET'S FISHING GUN.

The only structures in Japan which seem to be earthquakeproof are the pagodas, which are erected before temples. There are many which are seven or eight hundred years old, and as solid as when first built. There is a reason for this, and it lies in their construction. A pagoda is practically a framework of heavy timbers which starts from a wide base, and is in itself a substantial structure, but is rendered still more stable by a peculiar device. Inside the framework, and suspended from the apex, is a long, heavy beam of timber two feet thick or more. This hangs from one end, and to the other end are bolted, at each of the four sides, four more heavy timbers, and if the pagoda be very lofty, still more timbers are added to these. The whole forms an enormous pendulum which reaches within six inches of the ground. When the shock of an earthquake rocks the pagoda, the pendulum swings in unison and keeps the center of gravity always at the base of the framework. Consequently, the equilibrium of the pagoda is never disturbed, and this is the explanation of the great age of many of them, when, from their height, one would suppose them to be peculiarly susceptible to the effects of an earthquake.

IMPROVED PHOTOGRAVURE PROCESS FOR PRINTING FROM STONE, ALUMINUM, ZINC, OR COPPER—PRACTICAL DIRECTIONS FOR WORKING THE SAME.

By BENNO KOERNER.

HAVING worked this process for some time and having become convinced of its simplicity and certainty, and of the superior results obtained by it over the well known half-tone process, I will now give a description of its merits, advantages, etc.

By means of this process impressions are printed with transfer ink on transfer paper from bichromated gelatine plates, which are transferred either on lithographic stone, aluminum, zinc, or copper, from which, after the usual etching processes have been carried out, prints can be made almost equal to those by the Albertype or "Lichtdruck" process, with the important advantage that from my blocks much larger editions can be printed in considerably less time.

Still another advantage of this grain process is that effects are obtained that are impossible with the so-called half-tone process. In the first place, the character of the original is preserved. With this I mean, should the original to be reproduced be a steel engraving, the lines, dots, and tints characteristic to a steel engraving are preserved without the addition of the lines and dots of the half-tone screen produced in the half-tone process.

Further, no expensive screen is necessary, because the negative for the grain process is an ordinary negative, which would be used in printing on albumen paper. The only thing necessary is, that the negative should be reversed, that is, either made through a prism or stripped, if it is important that details of reproduction should be in the same position as originally. In explanation, suppose a man's portrait has to be reproduced. The picture shows that he parts his hair on the left side. If the negative were not reversed as to the position of the image, the reproduction would show that that man was in the habit of parting his hair on the right side, and might be objectionable.

The reversing of the negative is best done by prism, which becomes a necessity if negatives are for three-color work, because stripping would certainly interfere with the exact overlapping of the color prints. While either dry plate or collodion negatives can be used, I prefer a collodion negative, as with such a one the exposure on the bichromated gelatine film can be better judged, which is quite essential.

With the grain process, perfect, clear, high lights in the reproductions are obtained, where necessary, without extra working out by tedious scraping or etching, which is necessary in the half-tone process. Should there be clear, high lights in the original, the negative for the grain process would naturally by its character prevent the action of light on the bichromated gelatine film in those parts which represent the high lights, and, therefore, produce high lights in the reproduction, and not a smudgy effect noticeable in half-tone blocks.

Also there is a further advantage in case very large pictures are to be reproduced.* The largest reproductions I ever made with my method were 27 × 41 inches, picture size. The original was a large oil painting. I used four negatives each 18 × 22 inches, which I had to strip, as I had no prism to reproduce that size. These I exposed on four gelatine films 20 × 24 inches. From them I made the transfer impressions, which fitted together on a large sheet, were transferred on lithographic stone, from which an edition of 10,000 was printed. Nothing in the reproduction would indicate where the sections had been joined, because the irregular grain of the process is more favorable for such work than the regular lines of the half-tone process.

But one of the greatest advantages of the use of the grain process is in connection with the three-color process. Anyone familiar with the present method of this knows what a "drawback" the line screen is for the true rendition of the colors. The line screen simply flattens the whole effect. Where there are clear, bright lights in the original color negatives, a flat tint is produced by the line screen, and only through long, tedious etching and proofing and re-etching is it possible to get a result closely resembling the original.

The grain process makes use of the three original color negatives without the interposition of a screen! Then, again, by judicious rolling up the impressions on the gelatine films with the printing roller or etching of the films, effects can easily and quickly be altered, differing from those given by the negatives, so as to give the right effects necessary, as the negatives in three-color photography are somewhat faulty at the present state of the art, especially those for the red and blue color.

The expense for fitting up a plant for the manipulations of the grain process is small compared to the results obtained. In some cases it will not equal the cost of a good half-tone screen of the larger size. Other advantages of the grain process over the half-tone process might be mentioned, but will be self-evident to those familiar with this kind of work.

FORMULAS AND DIRECTIONS.

The best carrier for the gelatine film for the grain process is plate glass, about $\frac{3}{8}$ of an inch in thickness. Other carriers may be used, such as zinc or copper plates, but I prefer glass on account of its transparency, because through it the exposure can be judged.

The glass plates are finely grained on one side by means of emery powder, and can be used over and over again. I may mention here that graining the side on which the film will be carried has absolutely nothing to do with the formation of the desired grain, as that is produced by other causes. In fact, for graining the glass, I use only the finest powder, which only takes off the polish, if new glass plates are used. The plates can be cleaned again after use, either in a tank containing a strong solution of lye water or hot water, which takes off the old gelatine film. When the old film has by these means been removed, the plates are thoroughly washed and coated with the following solution:

Albumen	1 oz.
Water ammonia	6 drops.
Water	$2\frac{1}{2}$ oz.
Silicate of potassium	$\frac{3}{4}$ "

The albumen is obtained by the whites of eggs well beaten and then settled. This coating is a substratum for the gelatine film, so it will hold on to glass while printing and during the other manipulations.

Plates once used have always, after the removal of the gelatine film, to be ground again with fine emery powder, so to remove the silicate which does not come off with the means used to clean the glass from old gelatine films. After the plates have been thoroughly cleaned and washed, the albumen solution is poured over, then the plates are drained and allowed to dry spontaneously in a rack (away from all dust). Such plates thus prepared may be kept a long time. In fact, they can be made in advance and put away for future use. For use, wash the coated side of the plate in running water from five to ten minutes (the older they are, the longer) and then let dry.

GELATINE SOLUTION.

Gelatine	30 grammes or 450 grains.
Water	352 c. c. or 11 ounces.
Bichromate of ammonium	6 grammes or 90 grains.
Chloride of calcium	10 " " 150 "
Alcohol	80 c. c. or $2\frac{1}{2}$ ounces.
Water ammonia	$\frac{1}{10}$ " " 6 minims.

In regard to gelatine either Heinrichs or the Swiss gelatine (Dr. Eder's) will do. The chemicals should be pure.

To prepare the gelatine solution take the necessary quantity of gelatine (above amount I used as a unit, since with that amount of solution obtained I coated from four to five plates 14 by 17 inches in size; if more or less plates are to be coated, take in proportion) and wash well in several changes of running cold water, and let stand for about fifteen minutes in the last change, so it can absorb the water.

Weigh out the quantities of bichromate and calcium, put them in different bottles and add to each about one-fourth of the water required for the whole amount of the solution, and dissolve in a water bath, which is gradually heated up to about 45° Ré. (130°–135° F.) When both chemicals are thoroughly dissolved set aside in warm water bath. Take the gelatine, which in the meantime has been washed and soaked in cold water, squeeze out as much water as you can and weigh gelatine, to find out how many ounces of water it has absorbed. To do this, weigh off original amount of gelatine, and every ounce above this of the remaining gelatine will indicate near enough for our purpose the amount of ounces of water absorbed. Put the gelatine in a pot (ordinary glazed earthenware will do) and add the rest of water necessary according to formula. Put the pot in the water bath and warm solution up to about 40° Ré. (122° F.) After the gelatine has been thoroughly dissolved, which will be facilitated by stirring often with clean glass rod and will also prevent the formation of lumps of the gelatine while dissolving, add slowly the alcohol by constantly stirring the gelatine solution, as otherwise the gelatine will coagulate into flakes.

After the alcohol has been added, add first bichromate solution, then the calcium, then the ammonia by steadily stirring, so as to mix thoroughly. Filter the solution thus obtained several times through a felt filter (which is best formed in the shape of a pointed sack and can be easily obtained in most drug stores), and finally into a pot (best old fashioned coffee pot with long nozzle from bottom of pot) into which first has been put a piece of cheese cloth in form of a sack, reaching to bottom of pot and tied around top. This last is done to avoid air bubbles when the plates are being coated. Have the pot well warmed before solution is filtered into it.

COATING OF PLATES.

Before I describe the coating of the plates, it would be well to give a description of the drying box. The plates have to be dried under a certain degree of heat; therefore, the heating medium must be so arranged that it can be easily regulated. Either steam heat or heat by gas can be used, but the heat must be so distributed that it strikes the plates evenly. The plates coated with the silicate solution, washed and dried as above described, are put face upward in the drying box and warmed up, so the gelatine solution will not stiffen before the plates are evenly coated. While they are warming, level them so that the solution may not run off or to one side while drying. To do this, I use iron bars in the drying box above the heat distributer, with screws on which the plates rest. By means of the

* See George Seamoni's (St. Petersburg, Russia) Report of B. Koerner's transfer method for chromolithography. Photogr. Correspondence. April number, 1894.

screws which form a triangle for each plate the leveling can be done quickly.

After the plates are warmed up and leveled, I measure off in warmed small graduate 2 ounces gelatine solution for 14 by 17-inch plate. Take one plate and put it in the center on a bottle with a large protruding cork, so it will balance; take hold of the plate with the left hand on the left hand lower corner of the plate, dust the plate off and pour on the solution along the top of the plate and spread it with the aid of the right hand forefinger slowly, without causing any air bubbles, by gradually tipping the plate until the solution has arrived at the bottom; give the plate a gentle motion toward each side (without spilling any of the solution from the plate), so as to smooth out any possible irregular flow or unevenness of the solution, and put the plate, holding it level, on leveling screws in the box. (The covering of the top or lid of the box consists of a frame covered with orange colored cloth, which will allow the moisture to escape from the box and at the same time prevent the action of actinic light on the plates while drying. In the center of this box lid a thermometer is suspended in such a way that the bulb of the same is on a level with the plates, and also so that it can be easily removed for inspection.) Coat in the same way as many plates as you have in the box, shut it, and bring heat up as quickly as possible to about 60° Ré. (about 170° F.) Let it stand until dry. Take the plates out and put in a dark place to cool off until the degree of heat they have is about the same as it was before the first gelatine solution was put on. Have them rather cooler than too hot, before they are given the second coating. This is done the same way as the first coating, with the difference that you take 2½ ounces for 14 by 17-inch plate, and start coating from the opposite end from which you started the first coat. By all means avoid air bubbles, dust, etc., as such will mark the impressions. For plates of a different size than 14 by 17 inches take solution in proportion. Put the plates after they receive their second coating back into the box and bring heat up to the same amount of heat as before. The second coating has to be watched closer than the first in drying. If the plates get too hot and are not removed in time when dry, the gelatine solution may crack off the plates, taking pieces of glass along. The surest sign that the plates are dry is when there is a faint whitish color all over the film. When dry, put the plates into a dark place to cool off. Such plates can be made in advance and will keep their quality for nearly a week, if no light or great changes of temperature can strike them.

EXPOSURE UNDER NEGATIVE.

The negatives, which should be reversed ones, as previously mentioned, should not be too dense, but rather soft in effect, clear and full of detail. Negatives with very strong contrast between light and shade are liable to cause trouble under unfavorable circumstances, such as poor light, when exposing, etc. According to density of negative and strength of light the time of exposure varies from three to fifteen minutes in sunlight to from twenty minutes to one hour and a half in diffused light. The exposure, especially with collodion negatives, can from time to time be examined and judged by looking through the back of the glass plate in the printing frame. The gelatine film changes color from exposure to light. As soon as the places which will give the deepest shadows in reproduction are changed to brown and the bright lights commence a faint discoloration, and a light tint, different from places entirely protected against the action of light on the film, is noticed, the exposure should be stopped. To produce white, clean edges outside the picture on the transfer impressions, orange colored paper should be interposed between the light and film in the printing frame, so the light cannot strike the parts of the film which are outside of the picture it is preferred to print white. After the exposure under negative is made, the gelatine plate is taken out of the printing frame and put face upward into a dish containing clean water heated up to about 20° Ré. (80° F.) The water has to cover the entire plate, and there the gelatine film undergoes a decided change. Before the exposed plate is put into water, the film is perfectly smooth and does not show the grain, but as soon as water has a chance to permeate into the film, those parts which had been exposed to light show the grain, and warm water facilitates the formation of grain. While the thickness of the film on the glass, together with the ingredients of the gelatine solution, as well as the amount of heat used for drying, and the action of light, are the primary causes, water is the medium which really produces the grain. In the warm water, the fineness or coarseness can to some extent be regulated. For a fine grain the plate is left in the water about thirty seconds. The coarser the grain is desired, the longer the plate is left in the water, but there is a limit; two minutes should be the longest, as otherwise the film will get too soft and spongy in the high lights and the plate may thereby get spoiled. After the desired grain is obtained (which can easily be found by taking the plate out of the water, blowing the water off some exposed parts, and holding it up against the light, the grain can be examined), the plate is thoroughly washed in cool running water till the bichromate is washed out. After this washing the plate is put into a cool place to drain, and dry either spontaneously or by fans if transfer impressions are wanted quickly.

MOISTENING SOLUTION.

Stock solution:

Water	4 ounces	or	128 c. c.
Nitrate of potassium	70 grains	or	4½ grammes.
Chloride of calcium	20 "	"	1⅓ "
Chrome alum (in summer)	15 "	"	1 "
" " (in winter)	5 "	"	⅓ "
Citric acid	20 "	"	1⅓ "

Let each dissolve well before the next is added. For use take to one ounce of stock solution

9 ounces glycerine or 288 c. c.
4 " water " 128 "

and shake well. This solution can be used over and over again. Before printing in the printing press the films have to be moistened with the above solution. Put the plates film up on the table, level them and spread the solution evenly over the films to the edges of the glass, so that it will stand about one-eighth of an inch high. Avoid air bubbles on the surface of the film, as such will cause black spots on the impressions. The plates and solution should not be too cold, as may happen in winter time. The best temperature of the work room is from 70° to 80° F. The more contrast there has been in the negative used, the longer the plate has to moisten. The average time for a plate made from good, soft negative is about half an hour. The right time can also be judged. If there is a decided light color on the film in the deepest shadows, the moistening has to continue till this disappears. Then enough moistened solution is taken off with a soft sponge and the surface of the film dried with some absorbent paper. Old clean newspaper will do. After the back of the plate is thoroughly cleaned it is put into the printing press.

PRESS AND PRINTING.

An ordinary lithographic hand press is best adapted to make the transfer impressions from these plates. The surface on which the plate rests can be a smooth level stone or an iron bed. Either one is covered first with a sheet of white paper the size of the plate, on which the plate is laid, film up, of course.

For inking up for transfers for lithographic stone, take one-half part good quality lithographic ink and one-half part good quality crayon ink and mix thoroughly on ink slab. The first roller to be used for rolling up the plate is a lithographic leather roller that is well impregnated with transfer ink. With this the plate is rolled up slowly and carefully, so that the impression stands up quite bold. Then comes the use of a composition roller, such as is used by the provers of cuts for letterpress printing. Roll up on ink slab smoothly, without carrying too much ink, and finish with this the rolling up of the plate. Especially by the judicious use of the composition roller are the impressions perfected. By quickly rolling over the plate with light pressure, ink is taken off the plate, but by slow rolling and heavy pressure ink distribution is made heavier. By breathing over certain spaces of impression and following this up quickly by light rolling, the places are lightened up; by rolling some parts extra, impressions on these parts are made darker, etc. The printer will soon learn by practice the effective use of the composition roller.

After the plate is rolled up to secure desired effects (it will not dry on account of glycerine in film), a piece of transfer paper is laid over the plate, cover this with some backing sheets (not too soft), and the print is made by pulling through with just enough pressure to lift out the ink properly. Should the ink be too stiff, which may soon be found out, because only the deeper shadows of impression take ink, the ink can be thinned with lithographic varnish. Care should be taken that plate, bed plate, and ink slabs are not too cold. Any amount of transfer impressions that may be needed can be made. If no amount of quick rolling will take off the ink from the plate, that rolls up too heavily, wash the plate out with turpentine so that every trace of ink is removed, especially in the darkest parts, and dry the plate with absorbent paper, so that every particle of ink and turpentine is removed, and moisten again with glycerine solution. If even this, by a second rolling up, proves insufficient, the plate is overexposed. This may be remedied by again washing all the ink out as before and pouring over the film a solution of—

Acetic acid	3 parts.
Water ammonia	1 part.

Mixing well before use. Let this stand on the plate such a time as may have been ascertained by former experience, but certainly not longer than ten minutes, as a longer time would make the film spongy and useless for further use. Take off, dry the plate with paper, and put on glycerine solution again. Let the film moisten for a while, remove, and roll up again. A great deal of this kind of trouble may be caused by negatives with too strong contrast, as the deepest shadows take the longest time to moisten. A good soft negative, with all the details well defined, even in the deepest shadows, will be best all the way through the different manipulations and give the best results in the shortest possible time.

TRANSFERRING.

The manipulations to transfer these impressions on lithographic stone, zinc, or copper for letterpress printing are about the same. The surfaces are prepared as is necessary and essential for each stone or metal. If on stone, the stone is finely polished on the side to which the transfer is to be made. If additions have to be made on the stone after the transfer is made, the surface of that stone may be finely grained, so that the lithographer may draw the addition. After the transfer is made on stone and the impression is satisfactory in regard to sharpness of grain, etc., I would advise a preliminary etching of the impression on stone with a solution of tannic acid and water, say a teaspoonful of tannic acid to a pint of cold water. Wash with this the surface on which the transfer has been made for about thirty seconds, wash off with clean water, and gum the stone up with a thin solution of gum arabic and water. Let dry, and wash out under the gum (to avoid streaks), rub up and roll up as usual in lithographic work. The first etching with the nitric acid solution should be a weak one. After this proceed in the manner commonly used in treating stone work.

If transfers are to be made on zinc plates for letterpress printing, the plates should be well polished. After that I give the zinc plates a dip in a nitric acid solution, of nitric acid one ounce, water forty ounces, for about thirty seconds. While doing this I go over the polished surface of the zinc plate with a wad of absorbent cotton to remove the oxidized zinc, and clean off also thereby any possible impurities on the surface, and then give a good rinse in running water. The plates have to be dried quickly to prevent further oxidation. After this the transfer is made. For first dusting on of plate, I would advise the use of finely pulverized resin of the best quality, as this melts at a lower temperature than dragon's blood, and, therefore, prevents a running together of the grain dots in deep shadows where there are details, thus causing black blotches.

ALUMINUM FOR PRINTING PURPOSES.

Printing from aluminum plates has undoubtedly a great future, and this grain process is especially well adapted for it. By some chance (I could not get a negative that was reversed and could not make one from the one furnished for lack of time) I succeeded, and in a way which would save me in the future should I have to make impressions for printing from aluminum plates, several steps that were necessary if I had to make transfers on other surfaces for printing purposes and which had to show in the right direction. I made my usual exposure from the non-reversed negatives on the gelatine films, and when I reached the printing stage I made the impressions direct on the thin pliable aluminum plates, which brought the impressions reversed on the aluminum, and the prints from that in the correct position in regard to right and left.

The aluminum plate, before the print is made on it, is well polished and then dipped into a weak solution of nitric acid and water, which acid does not in the least change the surface of the metal in regard to its character. The dipping into this is done for cleaning purposes. After this the plate is well rinsed in running water and dried spontaneously. When the impression on the grain plate is rolled up, which can be done in this case with a good quality of crayon ink alone (without the mixing with transfer ink, necessary for lithographic stone work), I take the prepared aluminum plate, bend it a little so that the polished side for the reception of impressions forms a slight concave curve, the center being half an inch above the grain plate. The ends of the aluminum plate on which pressure starts and ends rest on the grain plate. Now cover the aluminum plate with several medium soft backing sheets (Bristol board or rubber sheets), put down the necessary pressure (which is before carefully tested, so it will lift out ink properly without smashing the film), about half an inch in from end of plate, and pull through quickly and lift off plate after pressure is removed by starting slowly on a corner. In this way astonishingly good results in regard to sharpness of grain and effects of impressions are obtained. Care should be taken that by pulling through under pressure the stop is made about the same distance on the end of the plate as on the start, as otherwise the impression might become blurred by the shifting of the aluminum plate when the scraper pressure runs over the end of the plate. The bending of the plate is necessary, because otherwise blurs might be occasioned where the plate comes in touch with the inked-up film, and shifting when pressure is put on. After the impression on the aluminum plate is made, I let the plate stand for about ten minutes. Then I proceed to the etching of the aluminum plate. For etching fluid I use:

Weak solution of gum arabic and water	16 ounces or 512 c. c.
Phosphoric acid	1 ounce or 32 c. c.
Tannic acid	½ teaspoonful.

Mix thoroughly. Then I put the aluminum plate in a clean dish and float over the etching solution quickly and evenly. Keep the solution in motion over the plate for about thirty seconds, remove the plate and rinse in running water, let dry, and gum up with weak solution of gum arabic and water. Let dry and wash out with soft ink rag under the gum and roll up to the proper effect, and either proceed with the printing or gum up with the formerly mentioned solution of gum arabic and water for preservation and protection of impression on plate.

In the same way I succeeded in making impressions on thin zinc plates, which are in use as substitute for lithographic stone. Proceeded in same way as in treatment with aluminum plate. The impression is powdered on with a good quality of dragon's blood, after which the plate is heated, cooled off again, and then etched.

In conclusion, I will say that if these instructions are strictly followed, especially in making the grain plates and printing therefrom, anyone with common judgment and sense will succeed. There is nothing in the different stages of the manipulations that would require special skill or that is difficult to acquire. The one thing necessary and absolutely necessary is cleanliness, and I am sure that is not so very difficult to obtain.

By cleaning the different vessels, etc., as soon as through with, the operator will be saved a great deal of trouble, extra work, and annoyance. Avoiding dust will do away with much of extra spotting out of imperfections in the reproductions. In case of failure, do not commence to change the formulas immediately, because you think it is their fault and you could improve them. In case of failure, think over your manipulation step by step and make comparisons. Do not think lightly of any of the details, because you may first consider them as unimportant; each one represents a certain cause, and will, in connection with the others, produce a certain effect, and, at least in the first trials, before you have found the reason for doing a thing as necessary to arrive at a successful termination, avoid all changes, because you might imperil the result. When you have mastered all details and found the reason for doing a thing in a certain way, because that way will lead to success (when cause and effect in this method are clear to you), you may branch out for improvements, if such can be discovered. In my hands this process has become a practical commercial success.

French artillerymen are quite enthusiastic over the merits of the new field gun, which is said to be giving the most marvelous results. Not only does the gun fire twenty-four shots a minute, but the accuracy of this almost continuous fire is reported to be perfect. With the old quick-firing guns, which required to be aimed after each shot, the men were inevitably disposed to lose their heads in the excitement and rush of the moment, with the result that the firing quickly became wild. The new gun not requiring to be reaimed, this drawback disappears. Once the direction is obtained, each shot gets home with infallible precision, while if it is required to alter the direction to either side of the range, the change is effected with the utmost swiftness by an extremely simple mechanism. The new guns are being turned out with great rapidity, and by the end of the year the army corps on the eastern frontier will be armed with them, says The Army and Navy Gazette. The expenditure of ammunition is, of course, enormous, and two ammunition wagons instead of one are now attached to each gun, which, though longer, is lighter than that it is to replace.

ELECTRICAL NOTES.

It is announced in the daily press that the Women's National War Relief Association was told, in answer to its request for information as to what it could do for the hospital ships, that electrical kitchens would be appreciated. The association proposes to supply such kitchens for the ship "Missouri," now being fitted out in Brooklyn.

In **Switzerland**, even after an ordinary snowfall, or during frost, the snow or ice deposited on the telephone wire equals fifteen times the size of the wire. At Zurich it reached as much as thirty times that of the wire, and the weight on a span of 100 meters would thus have a snow weight of 132 pounds. A post supporting 250 wires would therefore require to support a weight of 15 tons.

A new apparatus for representing the resultant of two pendulum oscillations in the same straight line, says The Engineer, formed the subject of a paper recently read by Prof. Righi before the Bologna Academy of Sciences. One of the two pendulums used consists of a leaden ring containing a cup filled with white sand, suspended by cords, and the length of this pendulum can be altered by raising or lowering a sliding piece. The second pendulum carries a table on which a piece of black paper is slowly drawn by clockwork, in a direction perpendicular to the plane of vibration, and the sand escaping from a hole in the cup of the upper pendulum traces out the vibration curves on the paper, the thickness of the line of sand being greatest where the motion is slowest, and vice versâ. By an electric arrangement the two pendulums can be started with any required difference of phase.

Mr. **W. Jaeger's** article in the Ann. Phys. Chem. on the behavior of cadmium amalgams in batteries is abstracted as follows in The Journal of the Chemical Society: As cadmium cells are employed in place of zinc cells as standards in E.M.F. measurements, it is of importance to ascertain in how far their behavior depends on the composition of the cadmium amalgam they contain. Direct measurements show that amalgams containing from 5 to 15 per cent. of cadmium exercise the same influence on the E.M.F., as this is not found to vary within one-hundredth of a millivolt. Amalgams containing more than 15 per cent. of cadmium do not give constant results, the E.M.F. rising gradually to that given by cadmium alone. An amalgamated cadmium rod is at first found to give the value obtained for the weak amalgams, but in a short time the E.M.F. rises in the direction of that of pure cadmium. This is evidently due to the diffusion of the mercury into the cadmium.

A very interesting case, says The Engineer, has recently been fought before the Italian law courts. The captain of the port of Leghorn, Cavaliere Alcesti Torrini, was the plaintiff in an action against the owners of certain wooden yachts with coppered bottoms lying in the Darsena part of the harbor of Leghorn to enforce a notice on the owners for the removal of such vessels from that part of the harbor. This notice was made on the grounds that the new warships and other iron and steel vessels lying in that part of the harbor were damaged by galvanic currents set up from the copper bottoms of the wooden yachts, the contact with the steel vessels being due to ropes which were made fast to different buoys in the harbor basin. The fact of the damage to steel and iron ships having arisen, and of its being due to this cause, was clearly established before the court, and the captain's order for the removal of the wooden yachts with coppered bottoms from the Darsena harbor of Leghorn was consequently confirmed by the court.

In the Otago district of New Zealand there are a number of electric power installations in connection with reefing work, and there has also been installed a large dredger worked by electricity, says The Western Electrician. Most of the steam dredgers used in this extensive district carry an electric lighting plant. At the present time more than 100 dredgers are at work in Otago province alone, and nearly all are conveniently situated for coal supply. In some parts of the province coal is very cheap at the pit's mouth, but outside of the neighborhood of the coal pits coal is extremely dear. At Queenstown £7 per ton is paid for household coal, £6 of which is paid for freight for the last 30 miles of the distance covered; 17s. 6d. per 200 pounds is paid for smithy coal. Freight rates are excessive. During the last twelve months there has been a large increase in the number of dredgers at work, and in most instances the results have proved very satisfactory, the dredger known as "Electric No. 1," on the Molyneaux, having obtained as much as 658 ounces of gold in five days, and, according to later reports, the average return of the dredgers per week has been little short of 100 ounces.

The boring of the tunnel for the Jungfrau Railroad, in Switzerland, has been progressing steadily in spite of the severe climate of the high Alps in winter, and as electricity is used not only for light and motive power, but for heating as well, where this is necessary, some new developments in the heating line have been worked out with great success. One of them is the warming of high explosives. On this work blasting gelatine is used, an explosive which freezes at about 40° F., and which is, in its frozen condition, very dangerous to handle, being unlike dynamite in this respect. The contractors who are blasting out the Jungfrau tunnel keep their explosive in a sort of safe heated by electricity, so that the danger of the gelatine freezing is entirely obviated. Dynamite or some other derivative of nitroglycerine is in very common use for blasting and other purposes, and is commonly frozen for safety, as this explosive is very inert at low temperatures. It is usual to thaw it out before it is used, and scarcely a week passes that the newspapers do not chronicle an accident from carelessness in the use of heat for this purpose. A dynamite thawer operated by electricity would be safe and perfectly regulable, as well as very convenient in use, and some manufacturer of electric heaters might find it worth while to investigate the needs of those using the explosive.—Electrical World.

MISCELLANEOUS NOTES.

There are 2,300 church bellringers in the diocese of Oxford. This is the largest number in any English diocese. Exeter comes second, and Devon third.

The first record of India rubber was made soon after the discovery of the New World by Columbus. The Old World rubbers were still unknown. During the second voyage of Columbus it was noticed that the inhabitants of Hispaniola (Hayti) played with balls made from the gum of a tree. This was just 400 years ago. Torquemada mentions for the first time the name of a rubber tree. That was the ule tree, of Mexico—Castilloa elastica—yielding Central America rubber.

A simple method to restore the illuminating power of mantles was reported by Franck to the Polytechnic Society, at Berlin. As is well known, the mantles relax in illuminating power after they have been in use for some time. This luminosity may be restored to a certain degree by blowing out the mantle from the inside during the burning, which can be accomplished with the aid of a small glass or paper tube. The president of the said society stated that he had personally tried this medium and had found it effective, and, in consequence, recommendable.—Nueste Erfind. und Erfahr.

Hokey-pokey ice cream sold in London streets, though full of bacterial life, turns out on inspection to be less harmful than was expected. The analyst's report says: "It contained upward of 500,000 organisms per cubic centimeter. The bacteria isolated were the Bacilli coli communis (the cream contained 200 to 300 per cubic centimeter), Streptococcus pyogenes, Straphylococcus pyogenes aureus, Straphylococcus pyogenes albus, Bacilli liquidus, liquefaciens, liquefaciens fluorescens and ubiquitus. No oidium lactis could be found, nor could any diphtheria bacilli be discovered." None of these microbes, however, are particularly injurious.

To counteract the effect of water upon lead pipe, Mr. Liebrich, in the Zeitschrift für angewandte Chemie of July 26, recommends the use of carbonate of soda as a means of counteracting the effect of water upon lead pipe. He says the essential causes of this attack upon the lead are the joint action of oxygen or of air and carbonic acid. The presence of bicarbonate of lime in the water limits the dissolving action by apparently interfering with the formation of carbonates of lead and zinc. Mr. Liebrich says that while the carbonate of lime diminishes the dissolvent action upon the metal, it does not arrest it completely. He, therefore, recommends the use of carbonate of soda, in a quantity that is sufficient to fix the carbonic acid, without rendering the water alkaline. He admits that when the water is in active circulation, as in the daytime, the quantity of lead in solution is extremely small; but he contends that in the morning, after the water has stood in the pipes all night, the dissolvent effect is very noticeable.

One of the most marvelous workmen in the world is Hananuma Masakichi, of Tokio, Japan, who has carved a figure in wood so like himself that when the two are placed side by side it is said to be almost impossible to tell which lives and breathes and which does not. By several connoisseurs in art this wooden figure has been pronounced the most perfect and human image of man ever made. Masakichi has faithfully produced every scar, vein, and wrinkle to be seen on his own body. The figure is composed of 2,000 pieces of wood, dovetailed and jointed with such wonderful skill that no seams can be detected. Tiny holes were drilled for the reception of hairs, and the wooden figure has glass eyes and eyelashes in which no dissimilarity to Masakichi's own can be detected. The Japanese artist posed between two mirrors while modeling this figure, and for some time after its completion he posed frequently beside it, to the confusion of spectators, who were often entirely at a loss as to which was the artist. The figure stands with a little mask in one hand, and an instrument for carving in the other; the lifelike eyes are apparently gazing at the mask, and the face wears a look of intense absorption.—Youth's Companion.

Two-thirds of all the letters which pass through the post offices of the world are written by and sent to people who speak English. There are substantially 500,000,000 persons speaking colloquially one or another of the ten or twelve chief modern languages, and of these about 25 per cent., or 125,000,000 persons, speak English. About 90,000,000 speak Russian, 75,000,000 German, 55,000,000 French, 45,000,000 Spanish, 35,000,000 Italian, and 12,000,000 Portuguese, and the balance Hungarian, Dutch, Polish, Flemish, Bohemian, Gaelic, Roumanian, Swedish, Finnish, Danish, and Norwegian. Thus, while only one-quarter of those who employ the facilities of the postal departments of civilized governments speak English as their native tongue, two-thirds of those who correspond do so in the English language. This situation arises from the fact that so large a share of the commercial business of the world is done in English, even among those who do not speak English as their native language. There are, for instance, more than 20,000 post offices in India, the business of which in letters and papers aggregates more than 300,000,000 parcels a year, and the business of these offices is done chiefly in English, though of India's total population, which is nearly 300,000,000, fewer than 300,000 persons either speak or understand English. Though 90,000,000 speak or understand Russian, the business of the Russian post department is relatively small, the number of letters sent throughout the Czar's empire amounting to less than one-tenth the number mailed in Great Britain alone, though the population of Great Britain is considerably less than one-half of the population of Russia in Europe. The South and Central American countries, in which either Spanish or Portuguese is spoken, do comparatively little post office business, the total number of letters posted and collected in a year in all the countries of South and Central America and the West Indies being less than in Australia. Chile and Argentina are, in fact, the only two South American countries in which any important postal business is done, and most of the letters received from or sent to foreign countries are not in Spanish, but in English, French, German, and Italian.—New York Herald.

SELECTED FORMULÆ.

Label Varnish.—Among the numerous formulæ for this article, the following is deserving of a high place: Reduce 6 parts of African copal to fine powder, and mix with it an equal weight of powdered glass; place the mixture in a bottle capable of holding 50 parts, and add 1½ parts of camphor and 25 parts of ether. Allow to digest during a month with occasional agitation. Then add 6 parts of absolute alcohol, shake well, and set aside for a fortnight; pour off the clear supernatant varnish for use. Paper to which this preparation is to be applied should be first coated with a solution of isinglass in a mixture of spirit and water (1:3 respectively).—National Druggist.

To Wash Silk Cravats, Handkerchiefs, etc.—Articles of silk may be washed so that they will retain their colors and preserve their new appearance. To do this, proceed as follows: Peel Irish potatoes sufficient, according to the size of the wash, grate them on a grater, put the grated material in a strong linen cloth, and twist this until all the juice is expressed. This juice is squeezed into the basin in which the article is to be washed. Sufficient rain water is now added, and the article—a cravat, silk handkerchief, or what not—is washed in the mixture, no soap or other detergent being used. The article is ironed in the usual way. The potato juice should be freed as much as possible from the solid matter that is squeezed through with the fluid, as otherwise the silk will be rather stiffer than is fancied by most persons. White silks thus treated never become yellow, though washed over and over.

To Clean Rusted Iron.—A simple and effective way of cleaning rusted iron articles, no matter how badly they are rusted, consists in attaching a piece of ordinary zinc to the articles, and then letting them lie in water to which a little sulphuric acid is added. They should be left immersed several days or a week until the rust has entirely disappeared, the time depending on how deeply they are rusted. If there is much rust, a little sulphuric acid should be added occasionally. The essential part of the process is that the zinc must be in good electrical contact with the iron. A good way is to twist an iron wire tightly around the object, and connect this with the zinc. Besides the simplicity of this process, it has the great advantage that the iron itself is not attacked in the least so long as the zinc is in good electrical contact with it. The August number of Domestic Engineering says that when there is only a little rust, a galvanized iron wire wrapped around the object will take the place of the zinc, provided the acid is not too strong. The articles will come out a dark gray or black color, and should then be washed thoroughly and oiled. The method is specially applicable to objects with sharp corners or edges, or to files and other articles on which buffing wheels ought not to be used. The rusted iron and the zinc make a short circuited battery, the action of which reduces the rust back to iron, this action continuing as long as any rust is left.

"Smoky" Insect Powder.—Besides punk, eucalyptus and common mallow leaves slightly dampened have been suggested to be burnt with insect powder to produce a greater volume of smoke. A little experimenting will probably reveal a number of other substances which will answer equally well. A formula for fumigating pastilles containing insect powder, and said to produce a considerable amount of smoke when burned, follows:

Charcoal	1	pound.
Saltpeter	2	ounces.
Carbolic acid	1½	"
Persian insect powder	8	"
Mucilage of tragacanth, q. s.		

Form into pastilles.—Pharmaceutical Era.

For Lime in the Eye.—In cases where lime is accidentally introduced into the eye the use of water should be avoided. The best thing for washing out the eye is a pure heavy petroleum oil. The use of a few drops of sirup has also been recommended, the object being to form a soluble compound with the remaining particles of lime.—American Druggist.

Antiseptic Papers.—Dr. Bedoin, in the Journal de Pharmacie de Liège, proposes to use the ordinary silk or cigarette papers as dressings for wounds, and to render them antiseptic, proposes to treat them as follows:

PHENOLATED PAPER.

Carbonic acid	1	part.
Vaselin	2	"
Paraffin	2	"

Melt together and impregnate the paper with the mixture.

SALICYLATED PAPER.

Paraffin	50	parts.
Vaselin oil	50	"
Salicylic acid	1	"

Melt together, and treat the paper as before.

SUBLIMATE PAPER (GODICKE'S).

Sublimate	2	parts.
Distilled water	500	"
Alcohol, 90 per cent	500	"
Glycerin	50	"

Mix, dissolve, and imbibe the paper in the solution.

ANOTHER SUBLIMATE PAPER.

Sublimate	20	parts.
Boiled distilled water	1,000	"
Glycerin	50	"

Mix and dissolve. Let the paper lie in the solution until completely saturated, then remove and dry in the sun.

HEMOSTATIC PAPER.

Solution of perchloride of iron	18	parts.
Alum	1	"

Mix. Paint the solution, previously warmed, over the paper, using a broad camel's hair brush.

ANOTHER.

Aluminum sulphate	2	parts.
Hydrated aluminum oxide	1	"
Benzoic acid	1	"
Solution of iron perchloride	6	"
Distilled water	4	"

Mix and paint over paper as before.—Nat. Druggist.

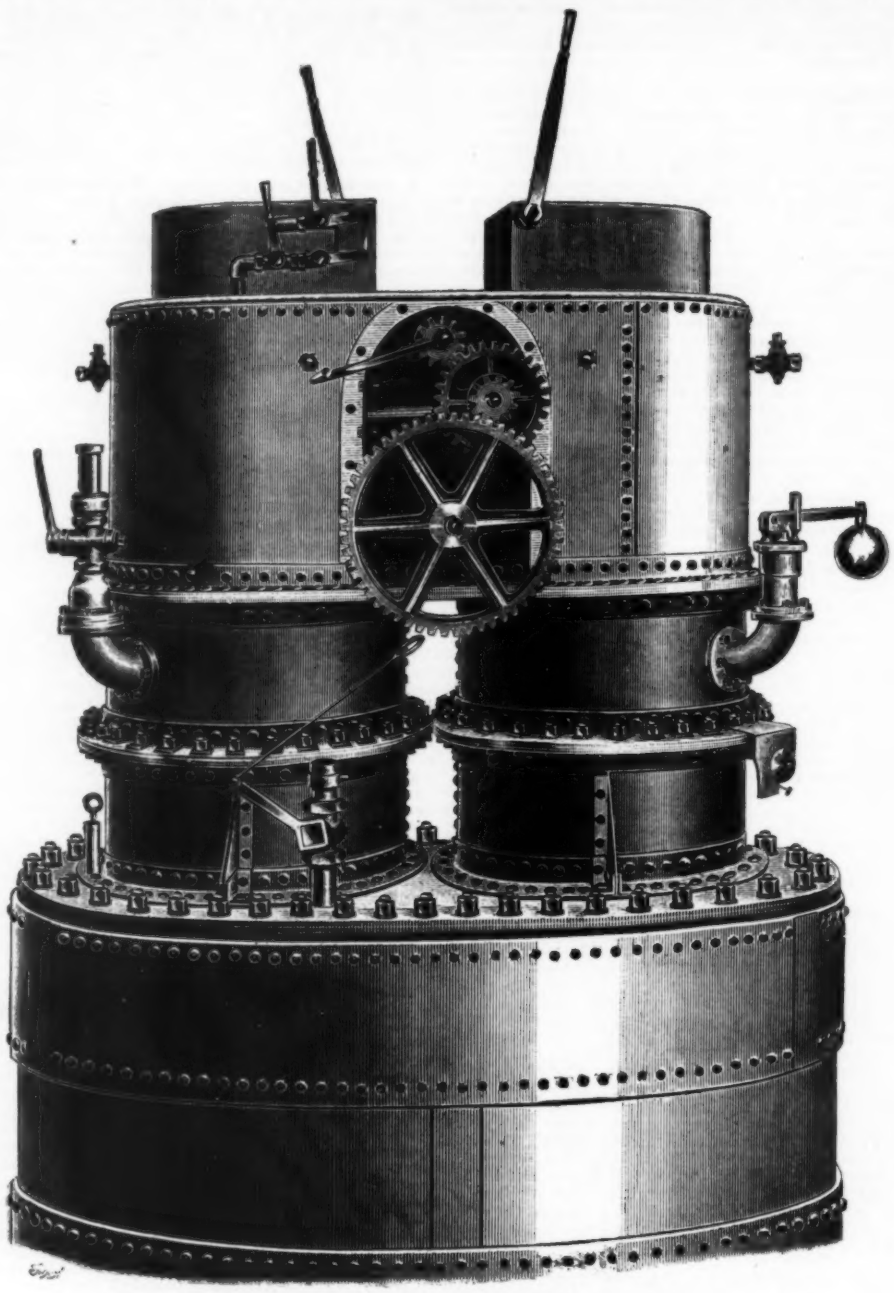
SINKING CYLINDER FOUNDATIONS IN VALPARAISO.

AMONG the works designed and executed in the port of Valparaiso for the government of Chile in 1874-83 was a wrought iron mole or pier, for the discharge of ocean-going steamers of the largest class.

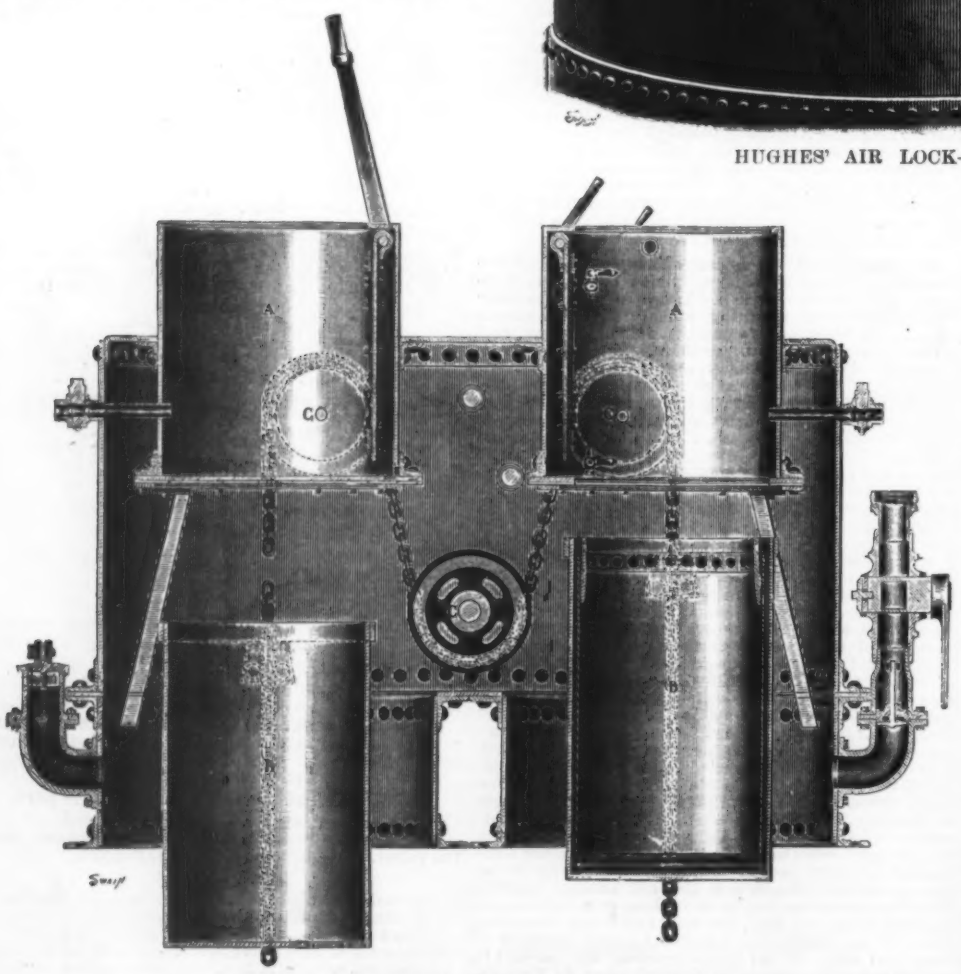
The special circumstances of the case—the great depth of water at a short distance from the shore, and the proverbially severe storms of "Valparaiso northers" to which the work would be subjected in the open bay—were the chief factors leading to the design for a pier which should present the least obstruction to the force of the storms, should be economical in construction, considering the depth of water—42 feet to 48 feet—and should also possess the advantages of convenience and permanence. In view of the conditions to be fulfilled, it was decided to build a pier of wrought iron girders supported on fifty-two wrought iron cylinder foundations, 11 feet 4 inches diameter, placed at equal distances, and sunk a sufficient depth into the bottom of the sea to give them the required stability. They were to be filled with Portland cement concrete and braced together by fender girders and the flooring of the pier. The superstructure was provided with hydraulic cranes for lifting ordinary merchandise up to 1½ tons and with one big crane capable of lifting exceptionally heavy weights up to 45 tons.

But it is not the purpose of this article to deal with the work as a whole, but with the pneumatic method used in sinking the cylinder foundations. The pneumatic apparatus used at Valparaiso was designed by the late Mr. John Hughes, M. Inst. C.E., at that time engineer-in-chief, who was well known in connection with this class of work from the time it was first used by him in sinking the foundations of Rochester Bridge in 1851. As will be seen by the accompanying illustrations, the latter form of apparatus presented many novel and interesting features. The cylinders themselves were formed of wrought iron, the bottom length of 15 feet being riveted together in one piece. The first 5 feet 6 inches from the bottom upward was formed of two thicknesses of ¾ inch plates riveted together, with rivets countersunk on the outside, and with the usual cutting edge at the bottom of the cylinder. On the inside were angle iron knees supporting a shelf 5 feet from the bottom, and closing an annular space between the outside cylinder, which was 11 feet 4 inches internal diameter, and an inner cylinder 8 feet in diameter, thus leaving the annular space exactly half the area of the whole cylinder, or 50 square feet. When this space was afterward filled in with concrete, weighing approximately twice the weight of water, it was sufficient to ballast the cylinder and compensate for the buoyancy created by the exclusion of the water by the compressed air.

The inner cylinder was made of ½ inch plates, and the outside, with the exception of the bottom 5 feet 6 inches, was made of ⅜ inch plates riveted together and stiffened with angle iron rings. With the exception of the bottom length of 15 feet, the outer cylinder was made in sections 8 feet long, with angle iron rings at either end for the purpose of joining them with one inch bolts. Owing to the large numbers of cylinders, and their comparatively short distances from one another, it was deemed expedient, in view of the rough weather to be contended with, to erect a temporary timber staging for placing the cylinders, rather than employ any other method, which might have presented various inconveniences in the transport of concrete and other material. On this timber staging, which, owing to the nature of the case, was in itself a work of some magnitude, six timber guides, 15 inches by 12 inches, by 14 feet long, were securely placed at the exact site for each cylinder. It was also furnished with three lines of rails for 45-ton traveling cranes, and with four lines of meter gage for trucks used in transport of concrete and in the removal of the excavated material, etc. The staging was 25 feet high above water level, and was made of piles 12 inches by 12 inches, stiffened with diagonal bracing above and below water.



HUGHES' AIR LOCK—VALPARAISO HARBOR.



VERTICAL SECTION THROUGH AIR BELL.

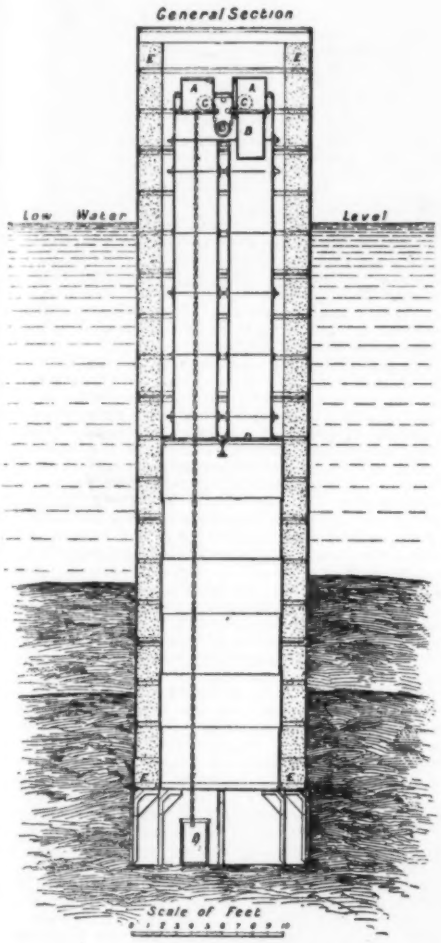
The operation of sinking a cylinder was as follows: Heavy temporary timbers having been placed on the lower part of the stage at about water level, forming a strong platform between the guides previously referred to, the bottom length of 15 feet was brought from the shore by means of a traveling crane, and deposited on it. The inner and outer cylinders were then built up to a height of 39 feet, and, weighing altogether close on 40 tons, were lifted by means of the traveler to a sufficient height to enable the timbers on which they rested to be withdrawn. The whole cylinder was then lowered into the sea until it floated by reason of the annular space between the inner and the outer cylinders. A wrought iron cover was then placed over the inside cylinder, the joint being made air-tight by means of inch bolts and packing. On this cover two lengths of 3 feet diameter shaft cylinders were bolted, and other lengths of these and of the outside cylinder were added, till the whole rested on the bottom, with the top of the cylinder rising above the upper stage. As the cylinder sank, the annular space was filled in with Portland cement concrete 3½ to 1 up to the height of the cover, and the concrete continued above that in the same form by means of temporary curbing. It was mixed by hand on bankers designed for the purpose, and placed one on either side of the cylinder, the material being brought from the shore in small tip wagons.

The cylinder in this position was ready for the reception of the bell or pneumatic apparatus proper. A section and elevation of this is given in Figs. 2 and 3, from which it will be seen that it consisted of a wrought iron case with semicircular ends made to fit on to the shaft cylinders, and was designed with the view of requiring no men under pressure except those actually engaged in excavation. The air locks were formed as follows: The two D-shaped cases marked A were furnished with covers or flaps worked from the outside by means of a hand lever fixed on the bar forming the hinge, which passed out through a small stuffing box, the joint between the cover and the top of the case being made air-tight by means of an India-rubber ring attached to the former. A similar ring was fastened underneath the bottom of the D-shaped case for the

purpose of forming an air-tight joint with the bottom portion of the air lock or skip case marked B. This was suspended by two chains of gaged links, one on either side, passing round the chain sheaves marked C, so that when both the D-shaped chambers were closed and the compressed air admitted, one skip case could be raised and the other lowered simultaneously by means of the winch worked on the outside, the main shaft of which passed from side to side of the air bell through stuffing boxes and carried the driving sheaves —marked C—on the inside. It was the top of either of the skip cases marked B coming in contact alternately with the rubber ring on the bottom of A which made the joint complete and allowed the air lock thus formed to be opened by letting the compressed air escape from the inside of it. The cocks for the inlet or outlet of compressed air to the air locks were 1¼ inch bore, and linked together so as to be worked by one lever, controlled on the outside by the man in charge. Smaller cocks, ¼ inch bore, were provided on the inside, to be used by the workmen coming in or out, so that they could control the rapidity of the change of pressure to suit themselves.

The buckets or skips for hoisting the excavated material were made to fit closely the inside of the skip case, and a convenient method of attaching a chain for emptying them was arranged by means of a pipe passing through from side to side of the bucket close to the bottom. Through this pipe a short bar of iron was thrust as it was raised from the air lock by a steam crane. The iron bar projected sufficiently on either side to admit of the attachment of the tripping chain.

The air bell was furnished with a signal gong, pressure gage, safety valve, and air supply connections,



with check valve and stop cock, as an additional precaution to be used in the event of a breakage in the hose joining the air supply pipe and the air bell. There was also a 3 inch cock in the cover of the 8 foot cylinder for use in case of its being necessary to eject water from the cylinder otherwise than by forcing it through the bottom. Means were provided also for attaching a small flexible pipe for drawing off compressed air for working a pump to supply water for the concrete. The arrangement was completed with a small wire rope ladder hung from beside the air locks and reaching nearly to the bottom of the cylinder, to enable the men to go up or down in case the machinery required adjustment in any way. It was at first intended to work the hoisting and lowering by compressed air by fitting steam cylinders to the winch on the outside, but labor being cheap enough, it was not thought necessary. The compressed air was furnished by means of a stationary engine on shore, with two air pumps, 15 inches diameter, 2 feet 8 inch stroke, surrounded by tanks of flowing water to keep them cool. It was led thence by iron pipes to within a few feet of the cylinders, the connection with them being made with a flexible hose, 3 inch internal diameter. As a rule, two foundations were sunk simultaneously. As the excavated material was removed from the bottom edge, the cylinders generally followed down by their own weight, but it was sometimes found necessary to let all the compressed air escape from the inside, and thus get rid of the buoyancy caused by the displacement of the water by the compressed air.

The great increase of weight brought into play by this means generally resulted in the cylinder sinking rapidly to a depth of 5 feet, 6 feet or more at a time, but there was always the risk of a considerable quantity of sand, etc., being forced in by the inrush of water from below.

When the cylinders were sunk to the required depth —which in some cases amounted to 107 feet below water—some 8 feet or 10 feet of concrete was put in carefully, and the air pressure maintained till it set.

It was during the hardening of this concrete that the chief use was made of the safety valve, which, by maintaining the pressure at a certain point, obviated the possibility of compressed air blowing out at the bottom of the cylinder, and so causing unsound work or troublesome leaks in the concrete.

The concrete put in under pressure was placed directly in the skip cases, which were tipped like buckets inside the cylinder, so that no buckets or skips were required.

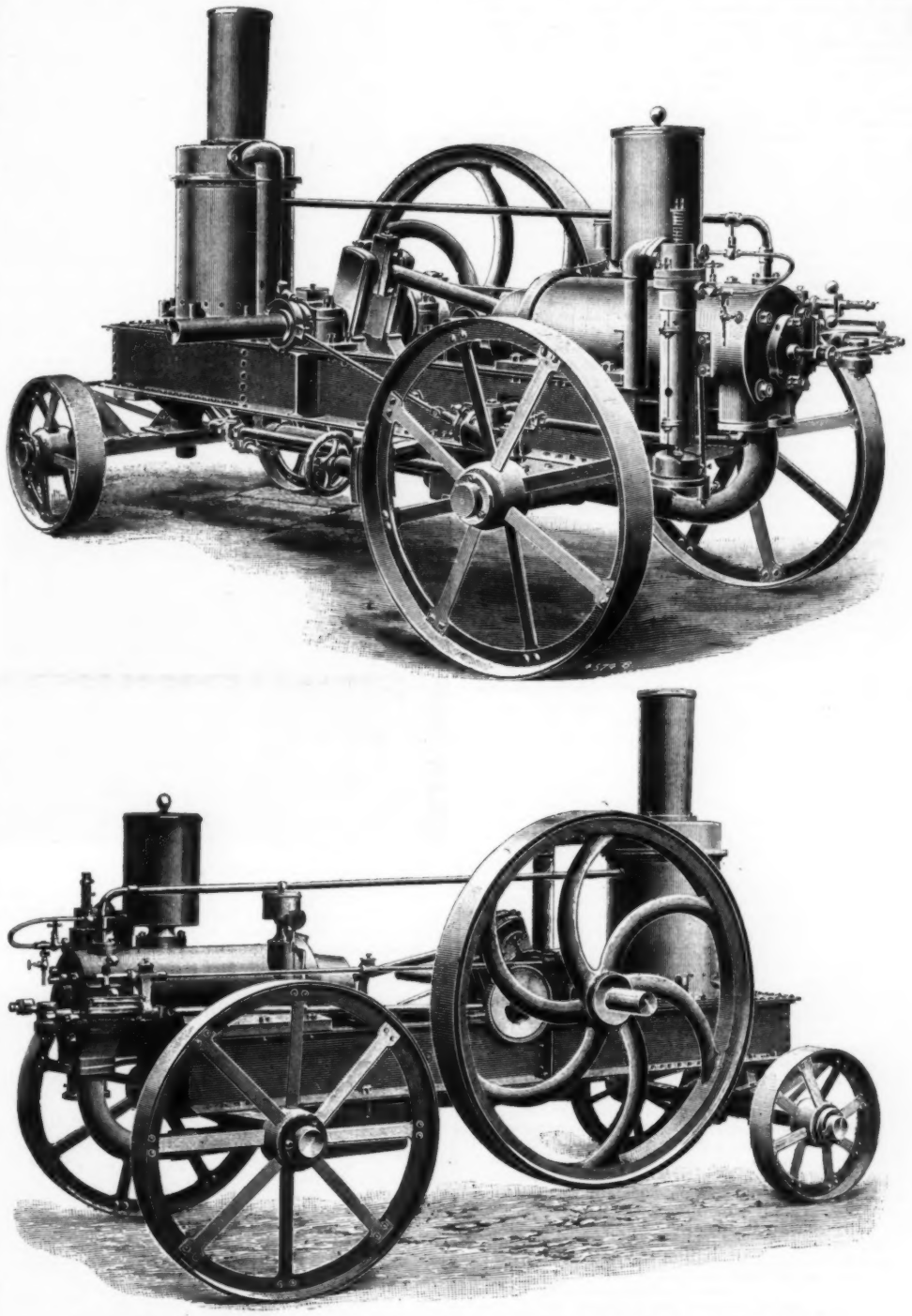
When it was sufficiently hardened, the pneumatic apparatus, including the cover of the 8 foot cylinder, was removed, and the whole of the cylinder filled up with concrete 8 to 1, cast in from above. Two men were employed under pressure at a time in each cylinder, working four hour shifts; and in some cases the usual results of working under compressed air were noted, viz., bleeding at the nose and ears, headache, rheumatic pains, etc., but, with one exception, there were no fatalities. In one case fatal results followed from the neglect of a workman to give the usual signal that it was a man and not material that was coming out. The consequence was that the pressure was released suddenly, and he found himself paralyzed from the waist downward. He at once went again under pressure, and came out gradually; but the mischief was already done, and the attempted remedy was of no avail. He died in the hospital some three months afterward from the indirect effects of the paralysis.

As a rule two cylinders were being sunk under pressure at the same time as two others were got ready for the operation.—The Engineer.

The 6-inch breech-loading guns of the battleship "Oregon," of which she has four, have been replaced with rapid fire guns and her funnels have been lengthened 10 feet to improve the running under natural draught. The old slow fire 6-inch guns on the "Massachusetts" are also changed for rapid firers and her funnels have also been lengthened.

CAMPBELL PORTABLE OIL ENGINE.

THE illustrations show a new design of portable oil engine made by the Campbell Gas Engine Company, Limited, Kingston, Halifax. The same design is utilized for several sizes, but the illustrations are those of the 20 brake horse power size. The objects aimed at in the designing of the new engine were: 1, reduction of weight; 2, low center of gravity; 3, better cooling of water supply; and 4, an arrangement of governing without belts. As to the first point, the truck is made up of two steel channels; the front portion being covered in to serve as a tank for the water. The back axle is riveted by light plates to the channels. The cylinder is bolted direct to the channel flanges, and the crankshaft is carried on two substantial pedestals, which are also bolted to the channel flanges. Stiffening tees and angles are riveted inside and outside to give rigidity. By adopting this method of construction, considerable reduction in weight has been achieved, so that for the 20 brake horse power size the weight



"CAMPBELL" TWENTY BRAKE HORSE POWER PORTABLE OIL ENGINE.

complete and in full working order is only 4½ tons. As to the second point, the center of gravity has been kept lower than usual by arranging the cylinder between the steel channels, the line of the engine being only about 2½ inches above the top of the girders. The quantity of water carried in the truck is approximately 40 gallons; this is pumped round the cylinder jacket, and then led to a cooler fixed on the front end of the truck. The cooling is effected by a powerful current of cold air being caused to traverse a series of trays, over which the heated water falls in spray. The current of air is caused by the exhaust gases creating a partial vacuum in the cooler.

The governor is driven direct from the crankshaft by skew gear wheels with machine cut teeth. This arrangement is preferred, as being less affected by bad weather than previous designs. The valve gearing and method of vaporizing the oil is the same as that used in the ordinary types of the "Campbell" engine. The moving parts of the engine are balanced as nearly as possible by weights fixed rigidly to the crank webs, while the crankpin is automatically lubricated when the engine is at work.—Engineering.

OPENING ADDRESS BEFORE THE BRITISH ASSOCIATION BY PROF. W. F. R. WELDON, M.A., F.R.S., PRESIDENT OF SECTION D.

In attempting to choose the subject of the address with which custom obliges your president to trouble you, I felt that I should have the best hope of interesting you if I decided to speak to you on the subject most interesting to myself. I, therefore, propose to discuss, as well as I can, the principal objections which are urged against the theory of Natural Selection and to describe the way in which I think these objections may be met.

The theory of Natural Selection is a theory of the importance of differences between individual animals. In the form in which Darwin stated it, the theory asserts that the smallest observable variation may affect an animal's chance of survival, and it further asserts that the magnitude of such variations and the frequency with which they occur are governed by the law of chance.

Three principal objections are constantly brought forward against this theory. The first is that the species of animals which we know fall into orderly series, and that purely fortuitous variations cannot be supposed to afford opportunity for the selection of such orderly series; so that many persons feel that if the existing animals are the result of selection among the variable offspring of ancestral creatures, the variations on which the process of Natural Selection had to act must have been produced by something which was not chance.

The second objection is that minute structural variations cannot, in fact, be supposed to affect the death rate so much as the theory requires that they should. And it is especially urged that many of the characters by which species are distinguished appear to us so small and useless that they cannot be supposed to affect the chance of survival at all.

The third objection is that the process of evolution by Natural Selection is so slow that the time required for its operation is longer than the extreme limit of time given by estimates of the age of the earth.

Now the first of these three objections, the objection to fortuitous variation as the source of material on which Natural Selection can act, is very largely due to a misunderstanding of the meaning of words. The meaning of the word Chance is so thoroughly misunderstood by a number of writers on evolution that I make no apology for asking you to consider what it does mean.

Consider a case of an event which happens by chance. Suppose I toss a penny and let it fall on the table. You will agree that the face of the penny which looks upward is determined by chance, and that with a symmetrical penny it is an even chance whether the "head" face or the "tail" face lies uppermost. For the moment, that is all one can say about the result. Now compare this with the statements we can make about other moving bodies. You will find it stated in any almanac that there will be a total eclipse of the moon on December 27, and that the eclipse will become total at Greenwich at 10:57 P. M.; and I imagine you will all feel sure, on reading that statement, that when December 27 comes the eclipse will occur, and it will become total at 10:57 P. M. It will not become total at 10:50 P. M., and it will not wait until 11 P. M. You will say, therefore, that eclipses of the moon do not occur by chance.

What is the difference between these two events, of which we say that one happens by chance and the other does not? The difference is simply a difference of degree in our knowledge of the conditions. The laws of motion are as true of moving pence as they are of moving planets; but it happens that we know so much about the sun and the earth and the moon that we know the circumstances which affect their relative positions very accurately indeed; so that we can predict within less than a minute the time at which the shadow of the earth will next fall upon the moon.

But the result of tossing a penny depends upon a very large number of things which we do not know. It depends on the shape and mass of the penny, its velocity and direction when it leaves one's hand, its rate of rotation, the distance of one's hand from the table, and so on. If we knew all these things before tossing the penny, we should be able to predict in each case what the result would be, and we should cease to regard pitch and toss as a game of chance.

As it is, all we know about these complicated conditions is that, if we toss a penny for a number of times, the conditions which give "heads" will occur about as often as the conditions which give "tails."

If you examine any event which occurs by chance, you will find that the fortuitous character of its occurrence always depends upon our ignorance concerning it.

If we know so little about a group of events that we cannot predict the result of a single observation, although we can predict the result of a long series of observations, we say that these events occur by chance. And this statement seems to me to contain the best definition of chance that can be offered.

If we used the word chance in this sense, we see at once that our knowledge of animal variations is precisely knowledge of the kind referred to in our definition of chance. We know with some certainty the average characters of many species of animals, but we do not know exactly the character of the next individual of these species we may happen to look at. So that in the present state of our knowledge it is à priori certain that the great majority of animal variations should occur by chance, in the sense in which we have used the phrase, and I will show you in a moment illustrations of the fact that they do so occur.

But before doing so I would point out the difference between the sense in which we have used the word chance and the sense in which it is used by many objectors to the theory of Natural Selection. Such epithets as blind, lawless, and the like, are constantly applied to chance; and a kind of antithesis is established between events which happen by chance and those which happen in obedience to natural laws. In many German writings especially this antithesis between Zufälligkeit and Gesetzmässigkeit is strongly insisted upon whenever organic variation is discussed.

This view of chance is not supported by experience; and indeed, if it could be shown that in any department of nature similar conditions did not produce similar effects, the whole fabric of human knowledge would crumble into chaos, and all intellectual effort would be a profitless waste of time. There is not the slightest reason to believe that any such absolutely lawless phenomena do exist in nature; so that we need pay no further attention to the writers who assume that chance is a lawless thing.

But if chance is a perfectly orderly and regular phenomenon, then the question whether animal variations occur by chance or not can be settled by direct observation. I will now show you one or two examples of events which undoubtedly occur by chance, and then compare these with one or two cases of organic variation.

As events which occur by chance, I have taken the results of tossing twelve dice. My wife has spent some time during the last two months in tossing dice for you, and I will ask you to look at the results.

Her first record gives the number of dice showing more than three points in each of 4,096 throws of twelve dice. There are, of course, six numbers on each of the dice; so that if all the dice were perfectly symmetrical and similar, the average number of dice with more than three points should be six in each throw of twelve. But dice are not symmetrical and similar. The points on the dice used were marked by little holes scooped out of their faces, and the face with six such holes scooped out of it was opposite to the face with only one such hole, so that the face with one point was heavier than the face with six points, and, therefore, six was rather more likely to be uppermost than one. In the same way, two was opposite five, so that the five face was a little more likely to fall uppermost than the face with two points. Therefore, it is a little more likely that you will throw four, five, or six in throwing dice than it is that you will throw one, two, or three.

Accordingly, the average number of dice in these 4,096 throws which had more than three points was not six, but 6·135.

To show you that this excess of high points was due to some permanent property of the dice, she threw these twelve dice another 4,096 times, and the average number of dice with more than three points was 6·139. A third series of trials gave an average of 6·104, and a fourth gave an average of 6·116.

You see that the difference between the highest

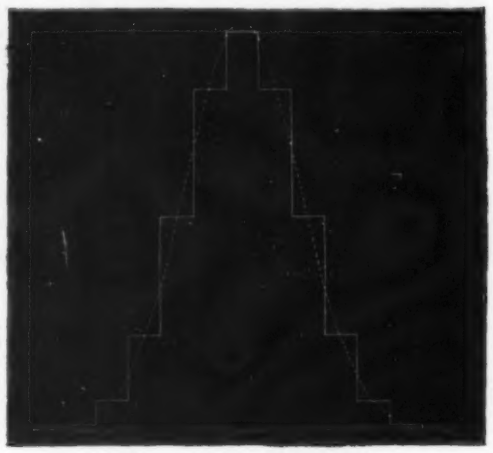


Fig. 1.

and the lowest of these determinations is only about one-half per cent., so that the mean result of such a series of fortuitous events can be determined with great accuracy.

And just as the mean of the whole series can be determined, so we can know with considerable accuracy how often any possible deviation from the average result will occur. The degree of accuracy with which we can know this may be judged from Table I.

Table I.—*Frequency with which Dice showing more than three Points were thrown in each of Four Series of Trials, the number of throws in each Series being $2^{12} = 4096$.*

Number of dice with more than 3 points.	Most probable frequency for symmetrical dice.	Observed frequencies.			
		I.	II	III.	IV.
12	1	0	1	0	1
11	12	11	13	8	14
10	66	71	86	61	66
9	220	257	246	241	241
8	495	536	540	513	586
7	792	847	836	856	861
6	924	948	913	948	866
5	792	731	750	802	728
4	495	430	446	420	474
3	220	198	198	182	204
2	66	60	55	51	67
1	12	7	12	13	6
0	1	0	0	1	0

You see that the results of the experiments agree fairly well with one another, and differ from the results most probable with symmetrical dice in the way which the structure of the actual dice would lead one to expect. Throws which give seven, eight, or nine dice with more than three points occur too often, throws in which only two, three, or four dice have more than three points do not occur often enough. You see, then, that each of these results is orderly and regular, and that the four results agree very fairly among themselves, not only in the mean value of each of them, but in the magnitude and frequency of departures from the mean. That they differ from the results which would probably be obtained with symmetrical and similar dice is only to be expected, because the dice used are neither symmetrical nor similar.

You notice that this table is very nearly symmetrical; the most frequent result is that which lies in the middle of the series of possible results; and the other frequencies would, with perfect dice, be distributed symmetrically on each side of it; so that with perfect dice one would be as likely to throw five dice out of twelve with more than three points as one would be to throw seven, and so on.

This symmetry in the distribution of the results is only found when the chance of the event occurring in one trial is even. The next table shows the result of

Table II.—*Frequency of Sixes in 4096 throws of Twelve Dice.*

Number of sixes.	Most probable number with symmetrical dice.	Number observed.
8	0·58	1
7	4·66	7
6	27·18	24
5	116·43	115
4	363·84	380
3	808·53	796
2	1211·44	1181
1	1102·56	1145
0	459·52	447

4,096 throws of twelve dice in which sixes only were counted. The chance against throwing six with any one of the dice is, of course, five to one; so that in throwing twelve dice you are more likely to throw two sixes than to throw any other number. But you see that the chance of throwing only one six is very much greater than the chance of throwing three; the chance of throwing none is greater than the chance of throwing four, and while there is a chance of throwing five, six, or more, of course it is impossible to throw less than none at all, so that the diagram is all askew. You see that this time, as before, the frequency with which any number of sixes did actually occur was as near to the result most probably with perfect dice as the asymmetry of the actual dice allows one to expect.*

These results will be enough to show you how absurd is the attitude which so many writers have taken up toward chance when discussing animal variation. The assertion that organic variation occurs by chance is simply the assertion that it obeys a law of the same kind as that which expresses the orderly series of results we have just looked at.†

That is a matter which can be settled by direct observation. But in order to express the law of chance in such a way that we can apply it to animal variation, we must make use of a trick which mathematicians have invented for that purpose.

It is a well known proposition in probability that the frequency with which one throws a given number of sixes in a series of trials with twelve dice is proportional to the proper term in the expansion of $(\frac{1}{6}+\frac{5}{6})^{12}$. The values in this table were calculated by expanding this expression. But if I had wanted to show you the most probable result of experiments with 100 dice, I should not willingly have expanded $(\frac{1}{6} + \frac{5}{6})^{100}$. The labor would be too enormous. Then again, suppose we are given a number of results, and are not told how many dice were used, how are we to find out the power to which we must raise $(\frac{1}{6} + \frac{5}{6})$, since this depends on the number of dice?

Before applying the law of chance to variations in which we cannot directly measure the number of contributory causes (the analogue of the number of dice), we must find some way out of this difficulty.

The way is shown by the diagram (Fig. 1).

The rectangles in this diagram are proportional to the various terms of $(\frac{1}{2} + \frac{1}{2})^{12}$; and they represent the most probable result of counting the number of dice with more than three points in a series of trials with twelve dice. The heights of these rectangles were determined by expanding $(\frac{1}{2} + \frac{1}{2})^{12}$; but you notice the dotted curve which is drawn through the tops of them. The general slope of this curve is, you see, the same as the general slope of the series of rectangles; and the area of any strip of the curve which is bounded by the sides of a rectangle is very nearly indeed the same as that of the rectangle itself.

The constants upon which the shape of this curve depends are easily and quickly obtained from any series of observations; so that you can easily and quickly see whether a set of observed phenomena obeys the symmetrical law of chance or not.

A good many characters of animals do vary in this symmetrical way; and I show you one, which will always be historically interesting, because it was one of the principal characters used to illustrate Mr. Galton's invaluable applications of the law of chance to biological problems. That is the case of human stature. The diagram (Fig. 2) shows the stature of 25,878 American recruits; and you see that the frequency with which each stature occurs is very close indeed to that indicated by the curve. So that variations in human stature do occur by chance, and they occur in such a way that variation in either direction is equally probable.

In cases where a variation in either direction is equally likely to occur, this symmetrical curve can be used to express the law of distribution of variations. And the great difficulty in applying the law of chance to the treatment of other cases was, until quite lately, that the way of expressing asymmetrical distributions by a similar curve was unknown; so that there was no obvious way of determining whether these asymmetrical distributions obeyed the law of chance or not.

The form of the curve, related to an asymmetrical distribution of chances, as the curve before you is related to symmetrical distributions, was first investigated by my friend and colleague Prof. Karl Pearson. In 1895 Prof. Pearson published an account

* It is unfortunate that I chose dice as instruments in these experiments. Dice are not only sensibly asymmetrical, but any ordinary dice are sensibly dissimilar; so that the result most probable with any actual dice is not given by a simple binomial expansion. The result theoretically most probable for the actual dice used could not be determined without very careful measurement of the dice themselves; and I was unable to attempt measures of the requisite accuracy. All that the records show, as they stand, is the amount of agreement between four successive observations of a fortuitous event.

† The law is not, however, identical in the two cases; see infra.

of asymmetrical curves of this kind, and he showed the way in which these curves might be applied to practical statistics. He illustrated his remarkable memoir by showing that several cases of organic variation could be easily formulated by the method he described; and in this way he made it possible to apply the theory of chance to an enormous mass of material, which no one had previously been able to reduce to an orderly and intelligible form.

In this same memoir Prof. Pearson dealt with another problem in the theory of chance, which has special importance in relation to biological statistics. It has doubtless occurred to many of you that the analogy between the complexity of the results obtained by tossing dice and the complexity of events was achieved. I will only say that it is experimentally justified by the fact that most statistics relating to organic variation are most accurately represented by the curve of frequency which Prof. Pearson deduces for the case where the contributory causes are mutually interdependent.*

The first case of an asymmetrical distribution in animals which I ask you to look at is the frequency of variations in the size of part of the carapace of shore crabs. The crabs measured were 999 females from the Bay of Naples. In this case the distribution of variations (see Fig. 3) is very nearly symmetrical, and in an account of these crabs which I wrote before Prof. Pearson's memoir was published, I treated them as symmetrical. The curve actually drawn on the diagram is

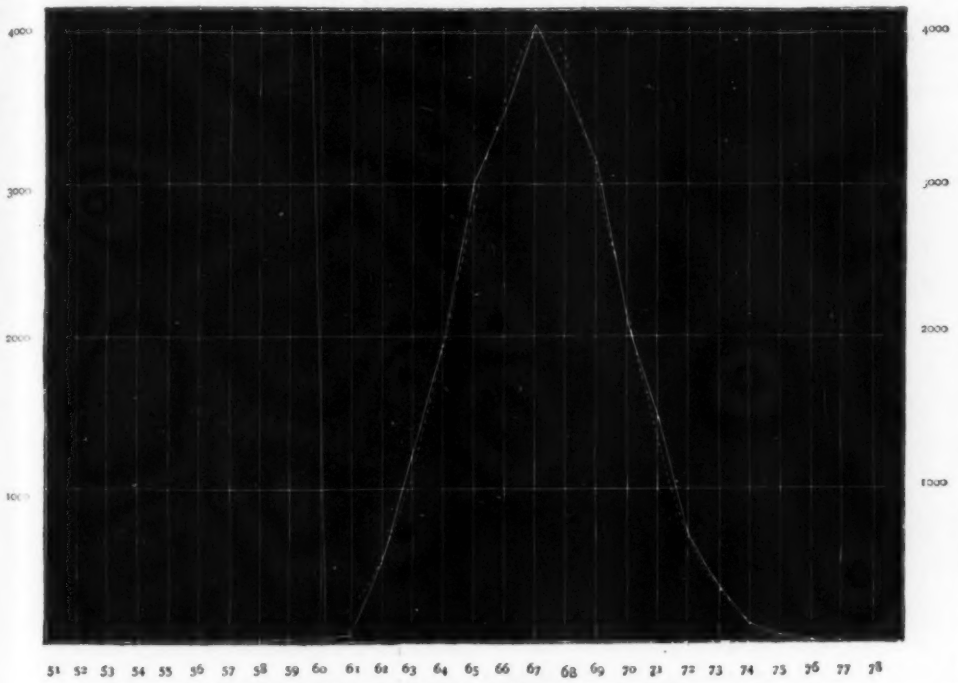


FIG. 2.—DIAGRAM SHOWING THE HEIGHT (IN INCHES) OF EACH OF 25,878 AMERICAN RECRUITS.

which determine the character of an animal body is false in an important respect. For the events which determine the result, when we throw a dozen dice on the table, affect each of the dice separately; so that if we know that one of the dice shows six points, we have no more reason to suppose that another will show six points than we had before looking at the first.* But the events which determine the size or shape of an organ in an animal are probably not independent in this way. Probably when one event has happened, tending to increase the size of an arm or a leg in an embryo, it is more likely than it was before that other events will happen leading to increased size of this arm or leg. So that the chances of variation in the size of a limb would be represented by a law similar to that which expresses the result of throwing dice, but different from it. They would more nearly resemble the result of drawing cards out of a pack. Suppose you draw a card out of a pack. It is an even chance whether you draw a red card or a black one. Suppose you draw a red card, and keep it. The chance that

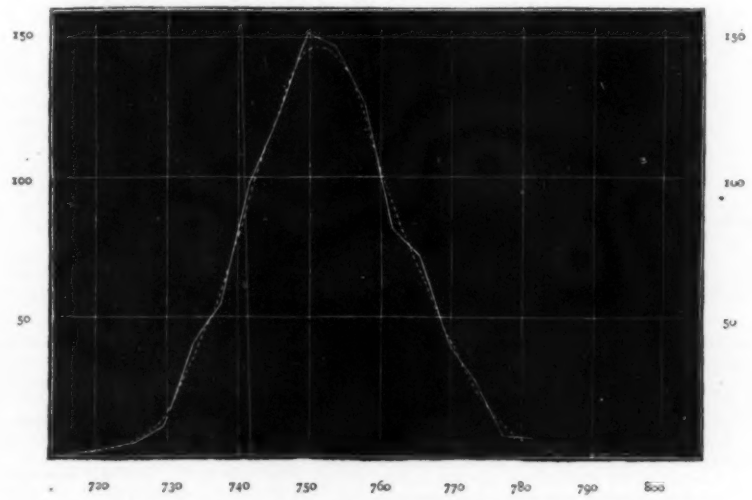


FIG. 3.—DIAGRAM SHOWING THE MAGNITUDE OF THE ANTERO-LATERAL MARGIN (IN TERMS OF CARAPACE-LENGTH) IN 999 FEMALE SHORE-CRABS FROM NAPLES.

your second card will be red is not so great as the chance that it will be black; because there are only twenty-five red cards and twenty-six black cards left in the pack.

Now, Prof. Pearson has shown how to deal with cases of this kind also; and how to determine, from the results of statistical observation, whether one is dealing with such cases or not.

I am no mathematician, and I do not dare even to praise the mathematical process by which this result one constructed by Prof. Pearson himself from the data given by my measurements of the crabs, and it fits the observations very sensibly better than the symmetrical curve. So that this dimension of a crab's carapace does vary by chance, but the chance of a given deviation from the mean length is not quite the same in both directions.

Now, admitting for the moment that these differences in the length of a part of the crab's carapace can affect the crab's chances of survival, you see that natural selection has abundant material on which to work. The production of this regular series of deviations from the mean length of the antero-lateral margin is as definite a character of the crabs as the mean itself; and in every generation a series of deviations from the mean is regularly produced, according to a law which we can learn if we choose to learn it.

Now suppose it became advantageous to the crabs, from some change in themselves or in their surroundings, that this part of their carapace should be as long as possible. Suppose the crabs in which it was shorter had a smaller chance of living, and of reproducing, than the crabs in which it was longer.

Suppose that crabs in which this dimension is longest were as much more productive than those in which it was shortest, as the most prolific marriages are more fertile than the least prolific marriages among ourselves. Prof. Pearson has pointed out that half the children born in England are the offspring of a quarter of the marriages. If we suppose the productiveness among crabs to vary as much as it does among ourselves, only that in crabs the productiveness is greater, the greater the length of this bit of the carapace, then half of the next generation of crabs will be produced by that quarter of the present generation in which the antero-lateral margin is longest. And as the offspring will inherit a large percentage of the parental character, the mean of the race may be sensibly raised in a single generation.

This view of the possible effect of selection seems to have escaped the notice of those who consider that favorable variations are of necessity rare, and likely to be swamped by intercrossing when they do occur. You see that in this case there are a few individuals considerably different from the mean in either direction, and a very large number which differ from the mean a little in either direction. If such deviation be associated with some advantage to the crabs, so that crabs which possess such abnormality are more fertile than those which do not, it is a certainty that the mean character of the next generation will change, if only a little, in the direction advantageous to the race; and the opportunity for selective modification of this kind to occur in either direction is very nearly the same.

(To be continued.)

* That is to say, if we know beforehand that the dice are symmetrical.

* Even the distribution of human stature, which has been so successfully treated by the older, so-called "normal" curve, is more accurately represented by a curve of Prof. Pearson's type; but in this case the difference between the two is so slight as to be inappreciable for all practical purposes; so that Mr. Galton's practice and Prof. Pearson's theory are alike justified.

HOME PORTRAITURE.

By "L'HOMME QUI RIT."

MOST amateur photographers have at some time or other experienced the disappointment of an unsuccessful attempt to take a faithful portrait in the open air. The operator having little control over the lighting of his subject, it is almost impossible to obtain the chiaroscuro essential to a faithful portrait; consequently, a flat, uninteresting picture is usually the result, alike disappointing to the operator and sitter. Of course, some improvement may be secured by an arrangement of screens and curtains, but these are generally too troublesome for the ordinary amateur.

We have not all at our disposal a studio with its equipment for obtaining those beautiful and faithful portraits which enhance the reputation of the first-class photographer. Yet, portraits taken in an ordinary room will, in many cases, compare favorably with those taken under more favorable auspices. In some things, indeed, home work has even the advantage over the studio, i. e., the sitter usually assumes a more natural pose, because the surroundings are more congenial, consequently a natural expression—one of the most important considerations in portraiture—is more easily obtained, and success secured. In our first attempts at home portraiture many difficulties may be expected which are absent in open-air work. The first of these will be the strong contrast between the lights and shadows, the former too bright and the latter too deep, and which produce those works of art commonly termed "soot and whitewash" photographs. It is, therefore, necessary that these harsh lights be corrected, and this may be done without much trouble or expense. We must aim at having the half-tones correctly rendered—e. g., the lights having a gradual blending, from the highest to the shadows. To secure this effect, the sitter must be placed, not parallel with the window, but at an angle of about 45 degrees, and about three to six feet distant, as the judgment of the operator may determine.

Under these conditions the contrast may still be too great, but a screen of white muslin stretched on a frame, and interposed between the sitter and the window, will make matters right; or tissue or newspapers pinned over the window will answer the same purpose. We ought now to obtain a portrait with the high lights accentuated and the half-tones merging into shadow. The shaded side may still be too dark, but this can be easily remedied by a reflector, not coming directly from the side, but a little in front.

Wonderful effects can be obtained by a judicious use of this reflector, but care must be used lest, by bringing it too near the sitter, cross lighting in the eyes may result, which is anything but a pleasing effect. A swinging mirror covered with some white material makes a capital reflector. It can be inclined at any angle to throw the light on the required place, and the covering takes away the glaring effect often noticed when a naked mirror is used.

It has often been argued that the light should not come from two sources, but this I do not quite agree with. A window not opposite, but a little in front, and lower than the light which illuminates the sitter, with a blind at sufficient distance not to cause cross lighting, will furnish a nice diffused light with sufficient shadow. As regards the best kind of window for the purpose, I prefer the form known as "bay," for with it, and properly adjusted blinds, another power is placed in the hands of the operator. A north light is also preferable, as it is steadier, and one is seldom troubled with a direct sunlight.

Backgrounds are necessary, and for bust pictures there is nothing better, in my opinion, than a graduated cloud effect, which if carefully handled will give a wonderful relief and tone to the subject. These can be had in paper or canvas very cheap, and I consider it a profitable investment for any one who is interested in the quality of their work.

Of course, the ordinary surroundings of the room may be successfully utilized for backgrounds, but care must be exercised that nothing detracts the eye from the principal object—viz., the face of the sitter.

All the care and trouble taken in the posing and arranging of your subject will, however, be in vain if you have faulty exposure or careless development, for the want of care in either of these operations may result in the losing of your delicate tones and sparkling lights. Exposures will be a little longer than for open air work, but by using a rapid plate it can be reduced to a minimum; in fact, in some well-lighted rooms I have been able to use a "Cadett lightning," with lens working at *f*/8, and secured a full-exposed plate in 1½ seconds. A few trials, however, will soon give the correct exposure. Softness being your aim, you must expose full and keep your negatives thin. A better result may be obtained by using a portrait lens, but if this is not available, expose with full aperture.

Now a word in conclusion. I am convinced that too

little care is taken with the pose of the sitter; this requires experience. However, always strive to have your subject as natural as possible, avoid stiffness or conventionality, and you will be surprised at your success. By following the directions I have here laid down, you will be able to add materially to your own reputation, and afford pleasure to your friends.

Negatives require a little retouching. If the amateur cannot do this, he had better allow someone versed in the art to do it for him.—Photographic News.

NICKEL STEEL.

There is probably no group of alloys that behaves in so unexpected a manner as the nickel steel one. Not that it obeys no rule, but that the laws that it follows are unlooked for and diverge as widely as possible from the rule of mixtures to which most of the alloys are subject, as regards a large number of their properties.

The single fact, known for a dozen years, that certain alloys of iron and nickel are not magnetic, shows us that we should not expect to find properties therein intermediate between those of iron and nickel. This, in fact, is what experience shows. If we look into the matter closely, we soon perceive that the absence of magnetism from certain alloys containing about 25 per cent. of nickel forms part of an ensemble of magnetic anomalies of which the following are the principal characters: Nickel steels with small proportions (and up to about 25 per cent.) of nickel may exist in two distinct states. When they are raised to a red heat they are not magnetic, but gradually become so when they pass through a certain region of temperatures so much the lower in proportion as they contain more nickel. When 25 per cent. is approached, the alloys must be cooled to below zero in order to become attractable by the magnet. After undergoing this treatment, they remain magnetic at all temperatures below that of red heat.

Above 25 per cent. the phenomenon changes in toto. The alloys resume their magnetism at the temperatures at which they lost them, and in the measure in which such property disappeared in the heating. The richer the alloy is in nickel, the higher is the temperature of the loss of magnetism. Slightly above 25 per cent. the alloys become indifferent to magnetism at the temperature of melting ice. At 40 per cent. they lose their magnetism toward 300°.

It is therefore through a singular accident that a very small group of alloys is not magnetic at the ordinary temperature. If such alloys had been studied only in the polar regions, none of them would have presented this peculiarity, while if the mean temperature of our atmosphere were higher, the group of non-magnetic alloys might have been considerably enlarged. These magnetic variations of the nickel steels become very striking when they are studied by means of an apparatus such as that represented in Fig. 1, the first model of which was constructed according to my directions by M. Radiguet. A small electro-magnet supports a brass reservoir, the bottom of which is traversed by soft iron cores that are connected with the polar pieces of the electro.

The steel rod to be examined is suspended from a scale beam that is balanced by weights. If the reservoir be filled with cold water, the stress necessary to detach the nickel steel rod may be considerable, but diminishes in measure as the water heats; and with certain proportions the attraction is seen to become annulled even before the water boils. However singular be these magnetic variations of nickel steels, their changes of bulk under the influence of heat are more curious still. M. J. Hopkinson has already shown that certain of these alloys may increase in bulk on becoming magnetic, and M. A. Chatelier has found that, in the two extreme states, the alloys possess different degrees of expansion.

Upon studying the phenomenon closely, I have obtained results of which the diagram in Fig. 2 gives a representation.

When an alloy of the first category is cooling from the temperature of the forge, it contracts in following a straight line such as *AB*, the inclination of which gives the coefficient of expansion of the alloy in the particular state in which it exists after heating. Then, when we reach a certain temperature, well determined for each proportion, the alloy ceases to contract, and begins to increase in bulk through cooling. But, if we reheat it, starting from a point, *D*, of such curve, it does not go backward, but starts again, on the contrary, according to a straight line, *DC*, that is slightly less inclined than the preceding.

If we cool it further, the alloy will describe the straight line in a contrary direction up to the point of intersection with the curve, along which it will begin to expand again if the cooling be marked. It is thus possible to cause an elongation of the bar under experiment as far as to 6 millimeters per meter. After this treatment, by cold, the alloy will be magnetic and, as we have seen, will not return to its first state unless it be heated to redness.

The alloys of the second category do not exhibit this singular phenomenon of a return by two different ways to heating and cooling; but their variations in bulk are just as different from those that prevail in the expansion of other alloys. Owing to the kind aid of M. Fayol, director-general of the Société de Commentry-Fourchambault, and of M. L. Dumas, secretary-general of this society, I have been able to make a protracted study of such variations. This study has necessitated the manufacture of numerous new alloys, all of which have been prepared and analyzed in the Imphy Steel Works belonging to the above named society. For such study, I have been able to make use of the very accurate instruments of the International Bureau of Weights and Measures. The diagram in Fig. 3 represents the results, as a whole, found from a study of these alloys. The proportions in nickel are shown in abscisses, and the true expansions in ordinates. Each of the five curves relates to a different temperature, the lowest being 0 and the highest 200°. The first fact that surprises us, upon an inspection of the diagram, is the great diversity of the expansions of the nickel steels between 26 and 44 per cent., and the great divergence with respect to the results that the law of mixtures would have led us to presume upon. The expansion of the first alloys shown in the diagram is greater than that of iron and nickel. Then it diminishes at the same time that an increase takes place in the proportion of the latter metal, passes through a minimum, and afterward increases and approaches normal values. Beginning with about 28 per cent., the expansion of the alloys is less than that of the components, and between 29 and 30 per cent. passes below the expansion of all the metals and alloys known. At a minimum, the expansion of the alloys of iron and nickel is equal to a tenth of that of platinum and to a twentieth of that of brass.

The diagram shows other interesting peculiarities; and one special point I shall dwell upon: A little beyond the minimum of expansion it will be seen that all the curves cross each other, this showing a proportion for which the alloy expands proportionally to the temperature. Beyond this point the curves are superposed in an order inverse to that of the beginning, so that, in this region, the expansion of the alloys diminishes in measure as the temperature rises. These two peculiarities have not hitherto been noticed in a metallic body.

The singular properties of nickel steels that have just been described allow us to foresee some interesting applications to which we shall refer in the future.—C. E. Guillaume, in La Nature.

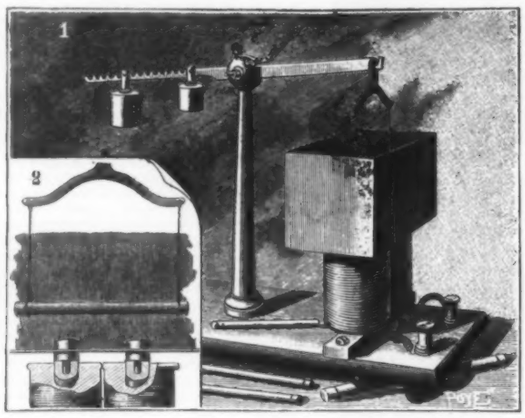


Fig. 1.—APPARATUS FOR THE STUDY OF THE MAGNETIC PROPERTIES OF NICKEL STEEL.

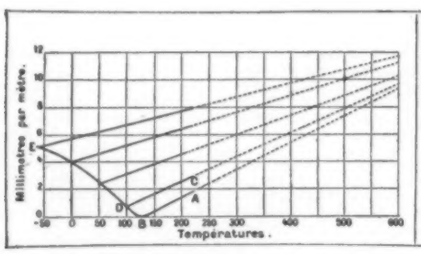


Fig. 2.—IRREVERSIBLE CHANGES OF BULK IN STEEL CONTAINING 15 PER CENT. OF NICKEL.

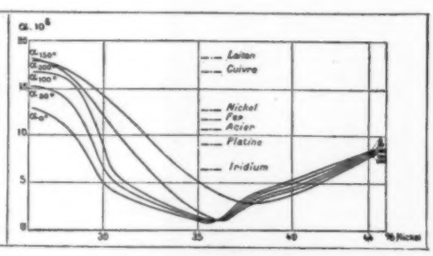


Fig. 3.—TRUE EXPANSIONS OF NICKEL STEEL ALLOYS CONTAINING FROM 26 TO 44 PER CENT. OF NICKEL.

TENEMENT HOUSE AGITATION IN BOSTON.

Our most conservative public opinion need not be alarmed at the slum-destroying proceedings of the Boston board of health while its spirit is that of the remark of its chairman, Dr. Durgin, at the hearing on Monday last. The law permitting the board of health to tear down buildings has been in force since April 1, 1897, on which day it was approved by the governor. In the fifteen months up to the present time the board of health has, according to Mr. Jordan, the chief inspector, "torn down," or more accurately and in the words of the law, "ordered to be removed," sixteen buildings. New York is the only other city in this country where the board of health has this power. There—even if the law went into effect immediately after its passage on August 9, 1895—within the first fifteen months the board of health condemned and ordered removed seventy-two buildings. Our health board refrained from using this important new power during nine months of last year. Hence in six months our board ordered sixteen buildings removed. But it is to be remembered that in one-half that time, in the three months between June 2 and September 1, 1896, the New York board ordered eighty houses removed.

The sixteen houses which our board of health has condemned housed, according to a statement recently published, "more than one hundred families." It appears that four of them had not been occupied by any families for many months, and probably for several years; in all the other twelve there were at the most fifty-six families, probably only forty-five. In the eighty houses which the New York board of health condemned in three months there lived two thousand seven hundred and ninety-six persons, or fully five hundred and fifty families. During the last six weeks all, or nearly all, of our newspapers and very many prominent citizens have declared that the time has come when Boston should take more radical measures than ever before to destroy all houses which are unfit for men and women to live in, unfit for our children to grow up in.

Mr. Birtwell well said at the hearing that there is more danger of going too slow than of going too fast in the destruction of these houses. Many persons have said that the descriptions of wretched and disgusting conditions given in the pamphlet of the Twentieth Century Club are a convincing proof of the need of going faster to get rid of our slums. Let any of our readers who wish for further proof of this remember what Dr. Durgin said, after carefully investigating the houses here described, and after listening attentively for nearly three hours to the various arguments of twenty-five or more speakers why these houses should be ordered vacated and removed: "With all the investigations that have been made by the committee of the club, they have not yet found the worst places in Boston, which the board of health knows about."—Boston Transcript. Condensed for Public Opinion.

THE COST OF "MUNICIPAL SOCIALISM."*

The term socialism, even in its formation, is essentially vague. But socialistic systems, while they are vague and inconclusive in regard to particulars, offer to-day in their general outlines a relative agreement. Socialism is now understood to mean a theory of society in which economic production is socialized or collectivized, that is, in which the means of production are held in common. In spite of the fact that the definition of Marx, of Malon, and of Bakounin differed somewhat from this, the word socialism has no longer the uncertainty which it once had. Coupled with adjectives, the signification of the word socialism, of course, varies. What, then, is to be understood by the expression "municipal socialism"? While to-day we hear a great deal about municipal socialism, no one seems to know exactly what it is. I have tried in vain to find a satisfactory definition. Finally, I have attempted to construct a theory by means of the facts.

At the recent international congress of socialists in London the municipalities of Saint Denis and Saint Owen were recognized as socialistic. In a recent volume issued from the statistical office of the department of the Seine for the most important municipalities of this department, outside of Paris, I find for 1895 the following eloquent data:

Communes.	Inhabitants.	Octroi.	Other Imposts.	Octroi Per Capita.
Vincennes	25,000	254,000	133,000	15·50
Ivry	22,000	282,000	113,000	17·95
Auberville	25,000	372,000	114,000	20·65
Clichy	30,000	555,000	93,000	21·60
Leo-Perret	40 000	766,000	164,000	23·25
Saint Owen	26,000	465,000	165,000	24·20
Saint Denis	51,000	1,080,000	185,000	24·80

These figures show that the socialistic municipalities of Saint Owen and of Saint Denis are at once distinguished from all the others by the large imposts which they collected. Roubaix has also been cited as a model socialistic municipality. Notice how in three consecutive years the entries of the municipality of Roubaix, thanks to the work of the socialists, increased.

1891.	1892.	1893.
4,620,460	4,726,035	5,319,203

Max Albert, who gives these statistics concerning the municipal financial operations of the socialists of Roubaix, adds: "Such, rapidly sketched, is the work of the socialistic Communal Council of Roubaix in the two years since it was elected. Behold what the workingmen of Roubaix have accomplished in two years!" And in manifest complacency he continues, "It was not upon the laboring class that this new impost fell." He concludes by saying that he leaves it "to all well disposed men to judge the work of the socialistic muni-

* G. Flamingo, in The Political Science Quarterly, Chicago. Excerpt.

cipality of Roubaix." Truly, I do not know what judgment well disposed men would form of the socialistic municipality of Roubaix, but the fact remains that while the socialists denounce all cases of taxes unjustly levied, Albert still boasts of what the socialists have done at Roubaix. It would be easy to cite many other cases of municipal socialism, especially in Belgium and in England. In England municipal socialism has advanced more rapidly than in other countries, and in that country the expenses of local public bodies, which were about fifty millions a few years ago, were in 1895 seventy millions, and the public debt of these local public bodies has increased from 2,300 million pounds in 1875 to 5,500 million pounds in 1895. That is, the public debt of English local bodies was almost trebled in twenty years, while in the same time the national debt decreased from nineteen billions to sixteen billions.

Knowing these facts, I follow the advice of August Comte and deduce from them the simplest hypothesis. Now, the most obvious and clearest deduction in our case is the following: Municipal socialism signifies a prodigious increase of the expenses of local public bodies. When the laissez faire economists were still alive, they affirmed that the tax collector is equally odious to the taxpayer, whether he comes in the name of the state or in the name of the local authorities. But at present laissez faire economists seem to be exiled to the planet Neptune. If they were still on earth they would without much difficulty demonstrate that public services performed by the municipality cost more and are not so well executed as they are when left to individual activity and free competition. In England, as municipal socialism prevails quite generally, all the more important cities have monopolized the tramways and the omnibuses. In his "Voyages and Discoveries" of Signor Faubert, lately published, Yves Guyot makes a very interesting comparison. He shows that in none of the principal cities of England are the means of transporting the people so well arranged, so convenient, and so swift as in London. An exception among the more important cities of England, the metropolis leaves this public service to free competition. For three or four pence one may ride across London, a distance of fully thirty miles. And yet, even in London, we find a growing tendency toward municipal socialism. The functions of its local governing bodies have been enlarged and an ever increasing burden of taxation has been laid upon its citizens. Already municipal scandals seem in order; such, for instance, as the boodling in the financial administration of the city discovered recently by Stead

MANUFACTURE OF PURE OXYGEN FROM WATER BY ELECTROLYSIS.

LORD KELVIN recently predicted that in four centuries, or in five at the most, our posterity will find it difficult to live, since at that epoch oxygen will be totally absent from the atmosphere. Neither he nor we shall be able to verify the accuracy of this sinister

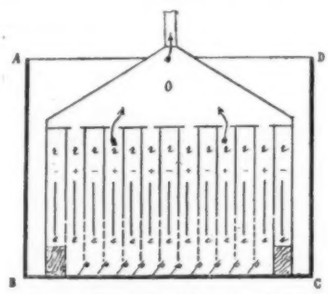


FIG. 1.—SECTION OF OXYGEN APPARATUS.

prediction, but for the moment, and regardless of what is to take place four or five hundred years hence, we persist not only in breathing to the full extent of our lungs, but even in employing oxygen industrially. What a wonderful bleaching and disinfecting agent this gas is! Whether it be in its natural state or converted into ozone, it has no rival from this point of view; and the physician has made one of the most efficient remedies of it in affections of the respiratory tracts. Up to the present, there has been worked, as an oxygen "mine," only the atmosphere, which, al-

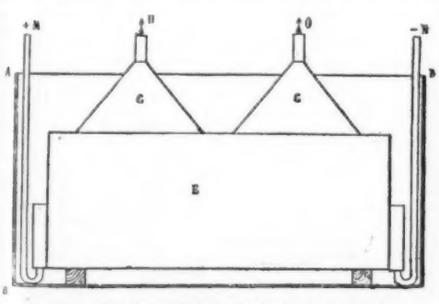


FIG. 2.—ELECTROLYZING APPARATUS.

A B C D, tank; E, electrolyzer; M N, terminals; *e e e*, electrodes; *p p p*, perforated diaphragms; *r r r*, cells; G, gasometer.

though apparently inexhaustible, is, according to the eminent scientist's prophecy, destined to give out in the future. There are, fortunately, other oxygen mines besides the atmosphere, and who knows whether it will not be to these new sources that our descendants will have recourse in order to prolong their existence? Water, in fact, contains immense quantities of oxygen that can be obtained from it through electrolysis.

It is a little more than a hundred years ago that Volta invented the electric pile, and a little less than a century ago that the voltaic current was employed for the first time in the separation of the elements of water. It was a very simple experiment that we have all seen tried in our youth. The feeble current from a pile gave the two electrodes that emerged from the bottom of a glass vessel a few bubbles of gas which, collected in small receivers, just sufficed to exhibit the phenomena that are characteristic of oxygen and hydrogen. Scientifically speaking, this was all, but, industrially speaking, it was nothing. The horse hour produced by a battery costs sixty cents. What can be done with such a motor? Fortunately, the dynamo has arrived upon the scene, hydraulic power has again come into favor, and now, under proper conditions, we have to pay less than a cent a horse hour; with steam and the dynamo it amounts to one or two cents.

Since we are masters of water, we can cause the circulation therein very cheaply of powerful currents for disengaging a large quantity of oxygen at the positive electrode, and a still larger quantity of hydrogen at the negative one. All we have to do then is to collect our gas. The trouble is that in operating in this way we shall obtain very impure gases, seeing that, once separated by electricity, they tend to dissolve in water that has not yet been decomposed, and also to become mixed. Our two gases must therefore be separated by a diaphragm that moderates such tendency; but, at the same time, we shall run the risk of preventing the motions of the electrolyte and interfere with the passage of the current. Then, farewell to the disengagement of the gas. The problem is, therefore, somewhat complex, and it is but quite recently that it has been solved, and that by the labors of Signor Garutti, the works installed according to whose system in Italy, Switzerland, and Belgium are operating very satisfactorily and economically. Very pure oxygen is here obtained at a cost of less than half a cent a cubic foot, and if we recall the selling price of this gas, we shall see that the margin of profit is large. The Brussels works belong to the Société Oxhydrique, which gave us permission to make a sketch of its apparatus.

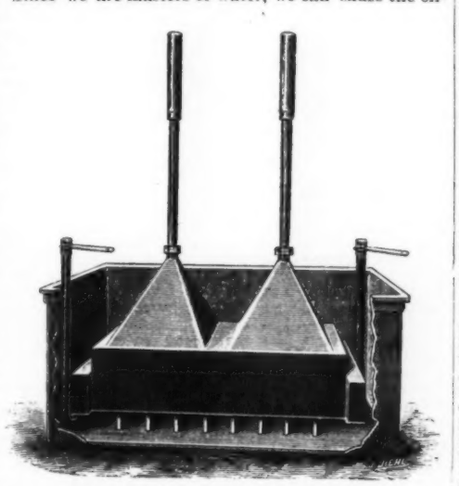


FIG. 3.—ELEVATION OF THE ELECTROLYZING APPARATUS.

The electrolyzer consists of a series of steel plate cells, and the bottom of the diaphragms which limit these is provided with very small apertures. The metallic nature of the walls assures a feeble resistance to the passage of the current. The apertures in the diaphragm permit the electrolyte (an eminently plastic liquid) to circulate freely, but the bubbles of gas are too large to pass through them. Therefore, there is no mixture to be feared. The cells are alternately connected with the gasometer specially designed for the reception of the oxygen or hydrogen.

Let us remark that the mixture of the two gases in the proportion in which they enter into the composition of water forms an excellent soldering gas. Hydrogen alone, burned by means of air, answers very well for the same purpose.

The mixture of the two gases of water has, besides, the valuable advantage in metallurgical operations of permitting one to obtain at will an atmosphere that is powerfully oxidizing or powerfully reducing. What great advantage may be derived from this gas for the treatment of ores in regions in which coal is wanting but where waterfalls exist can readily be seen.—La Vie Scientifique.

RECENT ADVANCES IN SCIENCE AND THEIR BEARING ON MEDICINE AND SURGERY.*

THE honor of being invited to deliver the second Huxley Lecture has deeply moved me. How beautiful are these days of remembrance which have become a national custom of the English people! How touching is this act of gratitude when the celebration is held at the very place wherein the genius of the man whom it commemorates was first guided toward its scientific development! We are filled not alone with admiration for the hero, but at the same time with grateful recognition of the institution which planted the seed of high achievement in the soul of the youthful student.

That you, gentlemen, should have intrusted to a stranger the task of giving these feelings expression seemed to me an act of such kindly sentiment, implying such perfect confidence, that I at first hesitated to accept it. How am I to find in a strange tongue words which shall perfectly express my feelings? How shall I, in the presence of a circle of men who are personally unknown to me, but of whom many knew him who has passed away and had seen him at work, always find the right expression for that which I wish to say as well as a member of that circle itself could? I dare not believe that I shall throughout succeed in this. But if, in spite of all, I repress my scruples, it is because I know how indulgently my English colleagues will judge my often incomplete statements, and how fully they are inclined to pardon deficiency in diction if they are convinced of the good intentions of the lecturer.

PROF. HUXLEY'S WORK.

I may assume that such a task would not have been allotted to me had not those who imposed it known how deeply the feeling of admiration for Huxley is rooted within me, had they not seen how fully I recognized the achievements of the dead master from his first epoch-making publications, and how greatly I prized the personal friendship which he extended toward me. In truth, the lessons that I received from him in his laboratory—a very modest one according to present conditions—and the introduction to his work which I owe to him, form one of the pleasantest and most lasting recollections of my visit to Kensington. The most competent witness of Huxley's earliest period of development, Prof. Foster, presented in the first of these lectures a picture of the rapidly increasing extension of the biological knowledge, which must have excited not only our admiration, but also the emulation of all who study medicine. Upon me the duty is incumbent of incorporating with this presentment the newer strides of knowledge and of stating their influence upon the art of healing. So great a task is this that it would be presumptuous even to dare to attempt its accomplishment in a single lecture. I have decided, therefore, that I must confine myself to merely sketching the influence of biological discoveries upon medicine. In this way also will the example of Huxley be most intelligible to us. I must here make a confession. When I tried to ascertain how much time would be required to deliver my lecture as I had prepared it, I found, to my regret, that its delivery would occupy nearly double the time assigned to me. I had therefore to reduce it to about half of its original dimensions. This could only be done by means of very heroic cuts, seriously damaging in more than one place my chain of ideas. If, therefore, you should find, gentlemen, that my transitions from one point to the other occasionally are of a somewhat sudden and violent character, I trust you will bear with me and remember that, if you should take the trouble of reading my address afterward, you will be less shocked than you may be to-day by my statements when they appear in print.

THE BEGINNINGS OF BIOLOGY.

Huxley himself, though trained in the practical school of Charing Cross Hospital, won his special title to fame in the domain of biology. As a matter of fact, at that time even the name of biology had not come into general use. It was only recently that the idea of life itself obtained its full significance. Even in the late middle ages it had not sufficient strength to struggle through the veil of dogmatism into the light. I am glad to be able to-day for the second time to credit the English nation with the service of having made the first attempts to define the nature and character of life. It was Francis Glisson, who, following expressly in the footsteps of Paracelsus, investigated the principium vitæ. If he could not elucidate the nature of life, he at least recognized its main characteristic. This is what he was the first to describe as "irritability," the property on which the energy of living matter depends. How great was the step from Paracelsus to Glisson, and—we may continue—from Glisson to Hunter! According to Paracelsus, life was the work of a special spiritus, which set material substance in action, like a machine; for Glisson, matter itself was the principium energeticum. Unfortunately, he did not confine this dictum to living substances only, but applied it to substance in general, to all matter. It was Hunter who first announced the specific nature of living matter as contrasted with nonliving, and he was led to place a materia vitæ diffusa at the head of his physiological and pathological views. According to the teaching of Hewson and Hunter, the blood supplied the plastic materials of physiology as well as the plastic exudates of pathology. Such was the basis of the new biological method, if one can apply such an expression to a still incomplete doctrine, in 1842, when Huxley was beginning his medical studies at Charing Cross Hospital. It would lead too far afield were I to recount in this place how it happened that I myself, like Huxley, was early weaned from the pernicious doctrines of humoral pathology.

THE DEVELOPMENT OF BIOLOGY.

When Huxley himself left Charing Cross Hospital, in 1846, he had enjoyed a rich measure of instruction in anatomy and physiology. Thus trained, he took the post of naval surgeon, and by the time that he returned, four years later, he had become a perfect zoologist and a keen-sighted ethnologist. How this was possible, any one will readily understand who knows from his own experience how great the value of personal observation is for the development of independent and unprejudiced thought. For a young man who, besides collecting a rich treasure of positive knowledge, has practiced dissection and the exercise of a critical judgment, a long sea-voyage and a peaceful sojourn among entirely new surroundings afford an invaluable opportunity for original work and deep reflection. Freed from the formalism of the schools, thrown upon the use of his own intellect, compelled to test each single object as regards properties and history, he soon forgets the dogmas of the prevailing system and becomes first a skeptic and then an investigator. This change, which did not fail to affect Huxley, and through which arose that Huxley whom we commemorate to-day, is no unknown occurrence to one who is acquainted with the history, not only of knowledge, but also of scholars. We need only point to John Hunter and Darwin as closely allied examples. The path on which these men have achieved their triumphs is that which biology in general has trodden with ever-widening strides since the end of last century—it is the path of genetic investigation. We Germans point with pride to our countryman who opened up this road with full conviction of its importance, and who directed toward it the eyes of the world—our poet-prince Goethe. What he accomplished in particular from plants, others of our fellow-countrymen

* The second Huxley lecture, delivered by Prof. R. Virchow at the opening of the winter session of Charing Cross Hospital Medical School, on October 3.

achieved from animals—Wolf, Meckel and our whole embryological school. As Harvey, Haller and Hunter had once done, so these men began also with the study of the "ovulum," but this very soon showed that the egg was itself organized, and that from it arose the whole series of organic developments. When Huxley, after his return, came to publish his fundamental observations, he found the history of the progressive transformations of the contents of the egg already verified; for it was by now known that the egg was a cell, and that from it fresh cells, and from them organs, arose. The second of his three famous papers—that on the relationship between man and the animals next beneath him—limned in exemplary fashion the parallelism in the earliest development of all animal beings. But beyond this it stepped boldly across the border-line which tradition and dogma had drawn between man and beast. Huxley had no hesitation in filling the gaps which Darwin had left in his argument, and in explaining that "in respect of substance and structure man and the lower animals are one." Whatever opinion one may hold as to the origin of mankind, the conviction as to the fundamental correspondence of human organization with that of animals is at present universally accepted.

OMNIS CELLULA E CELLULA.

. . . The greatest difficulty in the advance of biology has been the natural tendency of its disciples to set the search after the unity of life in the forefront of their inquiries. Hence arose the doctrine of vital force, an assumption now discarded, but still revealing its influence from time to time in isolated errors. No satisfactory progress can be made till the idea of highly organized living things as units had been set aside; till it was recognized that they were in reality organisms, each constituent part of which had its special life. Ultimate analysis of higher animals and plants brings us alike to the cell, and it is these single parts, the cells, which are to be regarded as the factors of existence. The discovery of the development of complete beings from the ova of animals and the germ-cells of plants has bridged the gap between isolated living cells and complete organisms, and has enabled the study of the former to be employed in elucidating the life of the latter. In a medical school where the teaching is almost exclusively concerned with human beings this sentence should be written large: "The organism is not an individual, but a social mechanism." Two corollaries must also be stated—(1) that every living organism, like every organ and tissue, contains cells; (2) that the cells are composed of organic chemical substances, which are not themselves alive. The progress of truth in these matters was much retarded by that portion of Schwann's cell-theory which sought to establish the existence of free cell-formation, which really implied the revival of the old doctrine of spontaneous generation. This belief was gradually driven out of the domain of zoology, but in connection with the formation of plastic exudates found a sanctuary in that of pathology. I myself was taught the discontinuity of pathological growths—a view which would logically lead back to the origin of living from non-living matter. But enlightenment in this matter came to me. At the end of my academical career I was acting as clinical assistant in the eye department of the Berlin Hospital, and I was struck by the fact that keratitis and corneal wounds healed without the appearance of plastic exudation, and I was thus led to study the process of inflammation in other non-vascular structures, such as articular cartilages and the intima of the larger vessels. In no one of these cases was plastic exudation found, but in all of them were changes in the tissue cells. Turning next to vascular organs, and in particular those which are the common seats of exudation processes, I succeeded in demonstrating that the presence of cells in inflammatory exudates was not the result of exudation, but of multiplication of pre-existing cells. Extending this to the growth in thickness of the long bones—which was ascribed by Duhamel to organization of a nutritious juice exuded by the periosteal vessels—I was thus eventually able to extend the biological doctrine of omnis cellula e cellula to pathological processes as well; every new formation presupposing a matrix or tissue from which its cells arise and the stamp of which they bear.

HEREDITY.

Herein also lies the key to the mystery of heredity. The humoral theory attributed this to the blood, and based the most fantastic ideas upon this hypothesis; we know now that the cells are the factors of the inherited properties, the sources of the germs of new tissues and the motive power of vital action. It must not, however, be supposed that all the problems of heredity have thus been solved. Thus, for instance, a general explanation of theromorphism, or the appearance of variations recalling the lower animals, is still to be found. Each case must be studied on its merits, and an endeavor made to discover whether it arose by atavism or by hereditary transmission of an acquired condition. As to the occurrence of the latter mode of origin, I can express myself positively. Equally difficult is the question of hereditary diseases; this is now generally assumed to depend on the transmission of a predisposition which is present, though not recognizable, in the earliest cells, being derived from the paternal or maternal tissues. But the most elaborately constructed doctrines as to the hereditariness of a given disorder may break down before the discovery of an actual causa viva. A notable example of this is found in the case of leprosy, the transmission of which by inheritance was at one time so firmly believed in that thirty years ago a law was nearly passed in Norway forbidding the marriage of members of leprous families. I myself, however, found that a certain number of cases at any rate did not arise in this way, and my results were confirmed by the discovery of the leprous bacillus by Armauer Hansen. In a moment the hereditary theory of the disease was overthrown and the old view of its acquirement by contagion restored. Precisely the same happened a few decades earlier with regard to favus and scabies. Another instructive condition is that known as Heterotopia, in which fragments of tissues or organs are found dwelling in a situation other than that which is normal to them. This is particularly the case with certain glands, such as the thyroid and suprarenal, but is also known with cartilage, teeth, and the various constituents of dermoids. It no doubt occurs by process of transplantation, the misplaced tissues developing no new properties, but merely preserving their normal powers of growth. The attempt to generalize from this fact and to attribute all tumor-formation to this cause carries the idea beyond its proper scientific limits.

PARASITISM AND INFECTION.

With regard to the subject of parasitism, the progress of scientific observation was retarded for centuries by the prevalence of the assumption made by Paracelsus that disease in general was to be regarded as a parasite. Pushed to its logical conclusion, this view would imply that each independent living part of the organism would act as a parasite relatively to the others. The true conception of a parasite implies its harmfulness to its host. The larger animal parasites have been longest known, but it is not so many years since their life history has been completely ascertained and the nature of their cysts explained, while an alternation of generations has been discovered in those which are apparently sexless. Very much more recent is the detection of the parasitic protozoa, by which the occurrence of the tropical fevers may be explained. As yet we have not complete knowledge as to their life history, but we hold the end of the chain by which this knowledge can be attained. The élite of the infectious diseases are, however, the work of the minutest kind of parasitic plants, bacteria, the scientific study of which may be said to date from Pasteur's immortal researches upon putrefaction and fermentation. The observation of microbes under exact experimental conditions and the chemical investigation of their products opened up the modern field of bacteriology, a science among the early triumphs of which were the discoveries of the bacilli of tubercle and Asiatic cholera by Robert Koch. In connection with this subject, three important landmarks require comment. One is the necessity for distinguishing between the cause and the essential nature of infectious diseases, the latter of which is determined by the reaction of the tissues and organs to microbes. Secondly, there is the relation between the smaller parasites and the diseases determined by them. This may be summed up in the general word (introduced by Prof. Virchow himself) "infection." But to assume that all infections result from the action of bacteria is to go beyond the domain of present knowledge, and probably to retard further progress. The third point is the question as to the mode of action of

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infection. It is only the larger parasites whose main effect is the devouring of parts of their hosts; the smaller act mainly by the secretion of virulent poisons. The recognition of this latter fact has led to the brilliant work of Lister on the one hand and to the introduction of serum-therapeutics on the other.

ANTISEPTIC SURGERY.

It would be carrying coals to Newcastle were I to sketch in London the beneficial effects which the application of methods of cleanliness has exercised upon surgical practice. In the city wherein the man still lives and works who, by devising this treatment, has introduced the greatest and most beneficent reform that the practical branches of medical science have ever known, every one is aware that Lord Lister, on the strength of his original reasoning, arrived at practical results which the new theory of fermentative and septic processes fully confirmed. Before any one had succeeded in demonstrating by exact methods the microbes which are active in different diseases, Lister had learned, in a truly prophetic revelation, the means by which protection against the action of putrefactive organisms can be attained. The opening up of further regions of clinical medicine to the knife of the surgeon and a perfect revolution in the basis of therapeutics have been the consequence. Lord Lister, whom I am proud to be able to greet as an old friend, is already and always will be reckoned among the greatest benefactors of the human race. May he long be spared to remain at the head of the movement which he called into existence.

ARTIFICIAL IMMUNIZATION.

It remains for me to say a word concerning the other great problem, the solution of which the whole world is awaiting with anxious impatience. I refer to the problem of immunity and its practical corollary, artificial immunization. It has already happened once that an Englishman has succeeded in applying this to the definite destruction of at least one of the most deadly infectious diseases Jenner's noble discovery has stood its trial as successfully, except in popular fancy, as he hoped. Vaccine is in all hands; vaccination is, with the aid of governments, spreading continually. Pasteur also labored with determination; others have followed him, and the new doctrine of antitoxins is continually acquiring more adherents. But it has not yet emerged from the conflict of opinions, and still less is the secret of immunity itself revealed. We must become well accustomed to the thought that only the next century can bring light and certainty on this point. Prof. Virchow, having referred with pride to the influence of cellular pathology in modern treatment, entailing, as it does, the principle of destroying the focus of disease by early operation, concluded his lecture in these words: May the Medical School of Charing Cross Hospital continue upon the newly opened path with zeal and good fortune. But may its students at the same time never forget that neither the physician nor the naturalist dares to dispense with a cool head and a calm spirit, with practical observation and critical judgment.

PHOSPHORESCENCE.*

IT is not possible in one lecture on phosphorescence to give any historical sketch which shall do justice to the work of those who have made a study of the phenomena. In a list of the names of the many who have enriched the subject with facts and with theories, those of Becquerel, of Stokes, and of Crookes stand out most prominently. Any attempt to make a sketch of our knowledge of phosphorescence and fluorescence must be to a very large extent an adaptation of the work and of the views of these masters.

The phenomena themselves may be divided into two main classes—those in which the evolution of light is associated with chemical change and those in which there is no evidence of such direct alteration. In the first class the commonest instances are connected with the process of oxidation. Examples of this kind are numerous. It is hardly possible to take any very easily oxidizable substance and to fail to get some evolution of light. Phosphorus, sodium and potassium, ether, many aldehydes, and a host of organic compounds may be cited as instances. The experimental illustrations of these are not, however, suited to an audience of more than a very few. The same may be said of the examples of animal and vegetable phosphorescence. It is proposed, therefore, to deal more especially with the second class, and to limit the experiments to the cases where the light given out is visible and not of such a character as to necessitate the use of a photographic plate. This evolution of light may occur in varying conditions. In instances such as solutions of quinine and fluorescein and many solids, of which thallene is a good example, the duration of the phosphorescence is so short that it may be said to last only while light is acting. Balmain's luminous paint is an illustration of the persistence of the phosphorescent light. With many minerals, notably some fluorspars and feldspars, light is given out when they are slightly heated, or in some cases only crushed.

The most brilliant phenomena are those which can be studied when many bodies are excited with electric discharges inside a Crookes vacuum tube, while outside of a slight modification of his focus tube fairly brilliant phosphorescence can be obtained by the action of Roentgen rays upon several substances, notably upon some of the platinocyanides.

In dealing with the whole subject of phosphorescence with the view of attempting to connect all the various phenomena together, it is convenient to divide it into—the nature of the substance giving out the light, the nature of the light given out, and the nature of the exciting causes.

With regard to the nature of the substance, either very much or little might be said; very much from the details of numerous experiments with a great number of compounds, but little from the point of view of general principle. The most important question in this respect is probably the question of the relation of phosphorescence to the purity of the substance giving out the light. Experiments with carefully prepared compounds of many metals make it clear that not a few substances can be made to exhibit phosphorescence when they are so free from impurities that none can be detected by any analytical methods. In some cases, however, there is either no light given out under any of the conditions for exciting phosphorescence or the light is so feeble that it is necessary to add impurities so as to obtain a suitable molecular condition for rendering a substance responsive to excitement. That the light given out is not to be ascribed to the impurity has been determined by many experiments with varying impurities and careful examination with the spectroscope. The further consideration of these physical and chemical conditions is better left until the other two aspects of the subject have been dealt with.

If a large number of observations be made of the phosphorescent lights given out by compounds of such metals, for example, as sodium, potassium, calcium, strontium and barium, magnesium and aluminum, it is hardly possible to avoid coming to the conclusion that the colors of these lights have a close resemblance to the colors of the lines and bands seen in the various spectra of the different metals and some of their compounds. Examination by the spectroscope confirms this conclusion in several instances. It is not suggested that the lines of the metals and the bands of their compounds are reproduced in the spectra of the phosphorescent lights. What is noticeable is that the maxima of light are grouped about these bands and lines, fading away from them and extending to other parts, so that a more or less continuous spectrum is seen with positions of greatest brilliancy. In the case of some specimens of lime these positions are well defined, and in some kinds of fluorspar the green and some red bands are well seen, either when the fluorspar is heated or when it is excited by discharge in vacuo. The questions of exact coincidence and of the shifting of the positions of the maxima of brightness seen with different compounds of the same metal need not be considered here. The intention is only to emphasize the similarity between the phosphorescent spectra of several metallic compounds and the spectra of these compounds, or of the metals in them, obtained in other ways.

In experimenting with phosphorescent compounds it is frequently noticed that specimens of the same substance in apparently the same state of purity give different colors. Confining attention for the present to lime, as a very infusible substance easily obtained in a state of purity, what follows will be made clearer

* A discourse delivered before the British Association on September 12 by Mr. Herbert Jackson.—From Nature.

by a brief consideration of the spectrum of the colored flame produced by holding some compound of calcium, e. g., calcium chloride, in the flame of a Bunsen burner.

The spectroscope breaks this red flame up into red, orange, and green bands and a blue line. For the moment the suggestion may be taken that these differently colored bands are indications of the existence in the flame of groups of particles of calcium compounds of varying degrees of complexity—the red being related to more complex groups, the orange to less, and so on. It seemed not unlikely that it might be possible by preparing lime from a great many calcium salts to obtain separate specimens which might preserve in the solid state some relation in their own molecular complexity to that of the salts from which they were obtained, or the conditions of decomposition of the different calcium salts might impress upon the residual limes different characters of molecular structure. The preparation of about 350 specimens of lime showed that it was quite possible to get specimens some of which phosphoresced red, some orange-red, some orange, others green, and some blue. Examination of their phosphorescent lights with the spectroscope showed, as referred to before, that the maxima of brilliancy in their spectra were grouped about the bands and lines of the usual spectrum of calcium oxide. The details of the preparation of these specimens of lime are too elaborate to enter into here, nor is it possible to do more than just to refer to their varying densities and different rates of hydration. Out of the number of specimens tried the most satisfactory were analyzed to make sure that it was really lime and only lime which was being dealt with in each case. In general terms it may be said that the most complicated organic salts of calcium yielded the best attempts at lime giving blue phosphorescence, simpler bodies gave green, while the best orange was obtained from Iceland spar, and the red from specially prepared calcium carbonate. That lime yielding a blue color was obtained from highly complicated organic salts does not contradict the former suggestion that perhaps it is really of simpler molecular structure than the others. Chemists are familiar with the conception that the complexity in structure arising from the massing of many molecules together in groups is probably often greater in bodies of apparently simple chemical composition than in those of a much more highly complicated nature.

The colors seen in the specimens of lime shown are not pure. In each one the other colors are present; thus the orange contains also the red, green, and blue, only these are masked by the greater proportion of the one color. Compare, for example, the light obtained from a vacuum tube containing the gas helium. In this case the color is yellow, although the spectrum contains beautiful red, green, and blue lines. If the different colors are related to varying molecular complexity in the substances, then it might be said that the lime showing a green light contains a large proportion of groupings of such a nature as to be capable of oscillating in a way to give rise to green light, and in like manner for the red, orange, and blue specimens. Whether it will be possible or is in the nature of things to separate out the different kinds in a state of purity can only be decided by further experiment.

The examples of different forms of lime have been so far exhibited only under the conditions obtaining in a high vacuum with an electric discharge. Before trying to show the points in common between these phenomena and the phenomena of phosphorescence in other conditions, it may be as well to consider briefly the character of the action in a high vacuum. The suggestion which follows is not intended to be anything but an imperfect attempt to bring all the phenomena of phosphorescence into line with one another.

When a discharge passes through a vacuum, there can be little doubt that the transferring medium is the residuum of gas in that partial vacuum. If the particles of this gas behave as visible masses are seen to do, they are probably attracted or are driven to the electrode, which is at high potential. Receiving the same kind of charge as this electrode, they fly off from it in that charged condition.

But if these particles consist of more than one unit, each unit, after the group has traveled a certain distance from the electrode, must repel each other unit in the same way as the whole little group was repelled from the electrode. If, however, the units making up the group are held together by that something which is called chemical attraction, a condition of strain is set up in which the electrical repulsion is striving to overcome the chemical attraction. Traveling unimpeded through the high vacuum, this condition of strain would be maintained until the charged group met with something capable of discharging it. At that moment of discharge the chemical attraction would assert itself; there would be a rushing together of the units composing the group, and an over-rushing, whereby oscillations would be set up. These oscillations, considered as blows or pulses, either directly or ethereally transferred to a substance, would set it in turn oscillating in a manner fitted to its own molecular structure, and its oscillations would in their turn give rise to the undulations which appeal to our eyes as the phosphorescent light. If, instead of the discharge taking place on a substance capable of responding to and absorbing most of the energy of the consequent oscillations, it were to occur on glass, platinum, or any of the materials which have been employed, it is conceivable that the oscillations would appear as short ethereal waves or, in other words, Roentgen rays. In the case of a low vacuum, or of no vacuum at all, the charged particles would discharge themselves against the intervening gas, which would in its turn respond to the rapid oscillation and give out its own particular colored light. The expression "short ethereal waves" is used intentionally, for if there should be forthcoming experimental evidence of the complex molecular structure of a gas, it is reasonable to suppose that in a high vacuum, with consequently a high potential at the electrode, the internal electrical repulsion in a group would tend to a dissociation resulting finally in the simplest form of system capable of separate existence in those conditions. It might be expected that the oscillation frequency of so simple a system would be very high.

Here it may be stated that this comes to practically the same thing as Sir William Crookes' original conception of radiant matter.

Leaving the method of electrical excitation in vacuo for obtaining phosphorescence, we may now turn to light as a source of oscillations. For the sake of simplicity it will be best to continue the experiments with the same substance, viz., lime. If this body be exposed to the light of the sun, of the electric arc, of a hydrogen flame, and of a great many other substances in a state of vigorous combustion, a phosphorescent effect is obtained, feeble in comparison with the results in vacuo, but apparently similar in kind. The best light for inducing the phosphorescence is the spark from a fairly powerful coil with a Leyden jar in circuit. Many specimens of lime go on giving out light for a considerable time after exposure. A cylinder of lime such as is used in the production of the lime light glows quite visibly when it is rotated before a jar spark.

The light from the sun is not so active in inducing this glow; but with suitable arrangements a fairly visible result can be obtained. The color of the glow from most lime made from limestones is an orange red, becoming a golden orange when the lime is heated. The introduction of glass, mica, or Iceland spar between the spark and the lime cuts off the glow at once; since these bodies are opaque to the undulations to which lime of this kind responds. Quartz, rock salt, and selenite are quite transparent.

It is found that the different forms of lime which have already been exhibited in vacuum tubes yield when exposed to the jar spark their specially colored phosphorescent glows. But these are difficult to see; they are very faint when pure specimens of lime are used. However, there is a way out of the difficulty. The faint light scarcely visible at the ordinary temperature may be increased very considerably by raising the temperature. As an extreme instance of this a specimen of calcium sulphide may be taken. After exposure to almost any source of white light this glows with a bluish phosphorescence which becomes quite brilliant when the sulphide is heated. A similar change is noticeable in the case of the different limes. The orange, green, and blue varieties exposed to a series of jar sparks, and subsequently dusted over hot plates, give with easy visibility the colors which they exhibited in the vacuum tubes and which may, for the present, be considered as sensible indications of their molecular constitutions.

Two important considerations have to be dealt with at this point. In the first place the question arises how far one and the same light, i. e., one and the same oscillation frequency, will excite the different specimens of lime. Without entering into dry numerical details, it is not possible to give a complete answer to this question. In a general sense, however, it is apparently true that, although the range of frequency is large, the red and orange varieties of lime respond to oscillations less rapid than those which readily affect the varieties giving a green or blue phosphorescence. It is possible to obtain a form of lime which illustrates this experimentally. It is not easy to make. It is prepared from calcium urate by heating this for many hours to a dull red heat, and afterward raising the temperature of the blackened mass sufficiently to burn off all the organic matter and leave only lime. The residue on analysis was shown to be really lime. Such a specimen exposed freely to jar sparks and afterward heated shows mainly an orange phosphorescence; but if glass or mica or Iceland spar be placed between the lime and the source of light, then the effect of heat is to intensify greatly a phosphorescence of a blue color. It must be clearly understood that this blue was there before, only masked by the superior brilliancy of the orange color; the undulations which would otherwise have affected the molecular groupings capable of giving out the orange light being cut off by the glass or mica. It would be tedious to give all the reasons for assuming that the oscillations exciting the blue phosphorescence are probably the more rapid. To some extent the transparency of glass and mica to X rays may be taken as confirmatory; but to follow the argument out from spectroscopic evidence and measurements would involve a discussion unsuited to a lecture dealing with general questions. Referring, however, to the suggested explanation of the action taking place in a vacuum tube, it is not inappropriate to mention now that it is possible to make a specimen of lime give an orange glow in a moderate vacuum while a portion of the same specimen is exhibiting a blue glow in a high vacuum. The readiness with which this blue glow appears, and the time which it takes to develop, must be taken into account in dealing with its supposed origin, and with its relevancy with the question of the relation of the rapidity of the exciting undulation to the wave length, i. e., to the color of the phosphorescent light. Perhaps it is advisable to leave this point for the moment, and to turn to the second consideration. This deals with the question of the duration of the phosphorescence.

At the beginning it was shown that some bodies glow only while light is acting upon them, or while they are under the direct influence of an electric discharge. In others there was a marked after-glow; while still others required the application of heat before any phosphorescence was visible, or, as in the case of the limes, before the phosphorescence was easily visible. With Balmain's luminous paint, or with any body which gives a marked phosphorescence that lasts for some time after withdrawal from the exciting influence, it can be readily shown that lowering the temperature reduces the brilliancy of the glow, but lengthens the time during which it lasts. The effect of heat has already been mentioned as vastly increasing the brilliancy; but it greatly diminishes the duration of the light. On the other hand, Prof. Dewar has shown that great reduction of the temperature will cause the phosphorescence to linger for a considerable time in many substances which had hitherto been considered as practically non-phosphorescent. The different behaviors of substances in this respect can, perhaps, be best brought under one explanation by applying the idea of a statical charge or a condition of strain to the phosphorescent substances themselves. Duration of phosphorescence would then be a measure of rapidity of discharge. If it be supposed that, the strain having been set up in the particles of a substance, these discharge themselves against one another, or rather against uncharged particles, then a substance with great freedom of transference of movement among its particles would fail to show any sign of phosphorescence; since the strain would be released or conducted away by rapid transference before a condition could be set up out of which oscillations of sufficient amplitude could arise. With rather less freedom of movement among the particles the non-conducting state might be reached by restricting the extent of that movement by cold, as in Prof. Dewar's experiment. Still less freedom of interchange may be considered to obtain in Balmain's luminous paint, and even less in the limes, which require heating to show up their phosphorescence; while, in the case of the chlorophane and many other minerals, the condition of strain, however set up, can apparently be retained indefinitely. Specimens of lime after exposure to the jar spark have been found to give out light when heated after being four years in the dark. It seems not altogether improbable that the influence of impurities in promoting phosphorescence may often be attributed to their interfering with the freedom of movement, and so permitting the groupings of the substance to be sufficiently highly charged. The effect of heat in rendering a substance a better conductor can be well studied with pure substances in vacuo under the electric discharge.

Under the vigorous bombardment of radiant matter the temperature of the substance rises. In some substances this leads to an increase in the brilliancy of the glow maintained, often even when the heating is very considerable; in others the hotter portions are marked out by a complete absence of phosphorescence. Observation seems to favor the conjecture that this absence is in many cases to be explained on the hypothesis that the heat endows the molecules with such freedom as to practically render them uninsulated. To pursue this part of the subject any further would lead to a discussion of a question that can only be referred to. It is the consideration of how far the change of glow in some specimens of lime from a red or orange color in a low vacuum to a green or blue glow in a high vacuum is to be attributed to shorter oscillations in the exciting cause, and how far the change is connected with a dissociation of complex groupings into simpler ones: a dissociation which may be considered to be brought about by the rapid oscillations breaking up the lime groups into two or more smaller groups. Connected with this is also the question dealing with the possibility of phosphorescence being coincident with the recombination of the separated smaller grouping; but this part of the subject can only be illustrated by experiments of too minute a character to be suitable to a lecture, and involves besides the study of too many details. One other thing which must be taken into account in drawing any deductions from the change in the color of the glow as the temperature rises is that in some cases the effect of heat is to discharge some colors in a complicated substance, and so leave visible others which were before masked.

The whole question of the inter-relations of the molecular weights of the phosphorescent substances, of the wave lengths of the exciting undulations, and of the wave lengths of the resulting glows is an important and interesting one; but it must be left alone in the present lecture with the statement, somewhat unsatisfactory it is feared, that, while there is no doubt that special undulations of measurable wave length are most efficient in exciting phosphorescence in some substances, the same effects can be produced, though to a less degree, by vibrations which can perhaps be best described as undifferentiated and irregular pulses.

Returning to the sources of oscillations, there is one other source which has yet to be considered, and that is chemical combination. The fact that many substances will phosphoresce during and after exposure to the flame of hydrogen has already been alluded to. The flame of coal gas burnt in a Bunsen burner will excite phosphorescence in many specimens of lime; but the effect is not strong enough to be shown to an audience.

Naturally this effect would be stronger the nearer the lime was placed to the source of light. Inside the flame itself would be the nearest attainable position, but then the heating effect practically masks or destroys all others. In phenomena such as the glow of phosphorus the temperature does not rise to any very marked extent. It is possible to obtain chemical combination in the presence of many bodies of a porous nature without, during the early stages of the action, getting very marked heating effects. The action of spongy platinum in inducing the oxidation of coal gas or alcohol vapor may be taken as a familiar illustration of the use of a porous material for this purpose.

In the case of a conducting metal it could not be expected that the oscillations arising from the chemical combination would cause phosphorescence even in the early stages, when the temperature has not risen to any extent; but if such a body as lime could be obtained in a very porous condition it might, while acting as an inducer of chemical combination, itself respond to the oscillations arising out of that combination.

This is found to be the case. A jet of unlighted coal gas allowed to play over warm porous lime produces a slight phosphorescence, very faint, but quite visible in a dark room.

By dusting easily volatile substances, such as finely powdered resin, over slightly heated lime, the oxidizable vapor is brought more closely into contact with the lime, and the phenomenon of phosphorescence is made more visible. So far, however, it has not been obtained with sufficient brilliancy to be shown to more than a few people at a time. When the different limes that have already been experimented with are subjected to oscillations from this chemical source, they yield their respective colors in the same way as before. The lime which showed a green glow in the vacuum tube, or when dusted on to a hot plate after exposure to the jar-spark, gives a green glow with the powdered resin. So also in the cases of the orange and blue yielding limes. The possibility of the phosphorescence being due to the resin vapor itself is excluded by control experiments with other porous bodies which do not phosphoresce, but yet are equally active in bringing about oxidation.

This phosphorescence was often well seen when some of the limes were being prepared in a furnace. (It has been already mentioned that many substances retain the power of phosphorescing at a high temperature, especially if they are in a very fine state of division or not quite pure.) Most of the limes were made from organic salts of calcium, and as the organic mat-

ter burnt away, a thin and scarcely visible flame played over the surface of the lime at the top of the crucible in which the calcination was carried out. It was frequently quite possible to predict by watching the glow which was developed in the lime what color would be given when the phosphorescence was brought about by oscillations from the other sources, such as the jar-spark or the discharge in vacuo.

No one who has spent much time in experimenting with various substitutes for lime in lantern work can have failed to be struck by the very different appearances of the light on the screen given by such bodies as magnesia and zirconia in comparison with lime; but, perhaps, the best examples are the two mantles in use at the present day for incandescent gas lights. One of them, the Welsbach mantle, gives a light of almost a white color. The other, or Sunlight mantle, shows a much pinker color to the eye.

Experiments with many substances used in a similar way to the mantles seem to indicate that, in addition to the ordinary heating effect of the gas flame, there is another and a phosphorescent effect which probably, so far as observation can tell, precedes the ordinary hot stage. It is not usual to find any pure substances capable of showing this phenomenon to any marked extent unless, as mentioned just now, they are in an extremely fine state of division; a condition which, like the presence of impurities, may be considered to be unfavorable to the too rapid discharge of the strained particles: thus giving them the opportunity of becoming fully enough charged to make their oscillations, when they are discharged, of sufficient vigor to be sensibly visible.

If either of the mantles mentioned be introduced into a tube and treated with an electric discharge in a high vacuum, the phosphorescent glow can be studied either with or without the heating effect. The glow of the Welsbach mantle is a greenish white, but not very marked. The Sunlight mantle gives a fine red glow. It is interesting to note that the glow shows great persistence even when the temperature of the substance has been raised very considerably by the vigor of the bombardment.

Having now dealt with the last source of oscillation which it was proposed to consider, it may be as well to summarize the conclusions which for the present seem to be the least open to objection so far as experimental evidence goes. The attempt has been made to connect together all the phenomena of phosphorescence with a view of showing between them a likeness in kind. Any theoretical suggestions should be taken only as hypotheses for assisting this attempt and for pointing the direction of further experiments. It is believed, then, that the following typical examples of the various phenomena which are described as phosphorescent phenomena are similar in kind and can be related to one another by the application of slight modifications of the same general principle—the glow of phosphorus, the fluorescence of quinine, the sparkling of heated chlorophane, the luminosity of Balmain's paint, the light from lime in a vacuum tube, and the glowing of barium platinocyanide under the influence of X-rays. To these it is proposed to add colored flames and the spectral light of glowing gases. It is suggested that all these phenomena may be looked upon as outward evidences of response on the part of the substances to rapid oscillations, whether these oscillations have their origin in chemical combination in what is commonly spoken of as light, or in electrical discharge. The nature of that response may in some cases be of a direct character; but, when account is taken of the many degrees of persistence of phosphorescence and of potential phosphorescence, it seems in many cases first to assume the form of something which, to avoid circumlocution, may be called a statical charge. The release of this condition of strain is accompanied by oscillations which give rise to the visible undulations of the phosphorescent light.

One final suggestion may perhaps be made, though it is mentioned with diffidence, as many may consider it outside of the subject.

If it be accepted that the light of the sun has its immediate origin mainly in the masses of luminous clouds floating in the photosphere, and if these clouds be considered as condensations into material of greater molecular complexity than that from which they were condensed, then it may be not altogether out of place in the present lecture to speculate on the relation between the actual light from the glowing clouds and possible oscillations of the particles of the medium in which they exist. There is no need to emphasize the idea that the oscillations of very simple molecular systems give rise to undulations which can only be perceived when, by their action upon something more complex than themselves, they cause either a distinct chemical change or set up undulations within the range of the visible spectrum.

May it be that there are similar oscillations in the sun, that the simpler materials out of which the photospheric clouds are condensed vibrate too quickly to give out visible light, but that their oscillations are rendered visible when they are absorbed and responded to by the more complex groupings of the condensed masses? A sun-spot, looked upon as a partial absence of clouds, would mean that the conditions which serve to screen us to a great extent from the rapid undulations have been somewhat modified.

Is it too much to suppose, in view of the close resemblances between many of the actions of light and electricity, and of the well-known electrical effects of ultra-violet light and of X-rays, that the breaking down of a dielectric which they can accomplish may, on a vastly larger scale, accompany an unusual exposure of the earth to similarly rapid undulations? Should there be anything in this suggestion, it may help to remove a part of the difficulty in relating the presence of sun-spots to those casual electrical disturbances with which they undoubtedly coincide in point of time.

According to W. J. Hotchkiss, secretary of the Wine Makers' Corporation, of California, which includes 80 per cent. of the growers, the vintage this year will be one of the smallest in the recent history of the State. He says: "Our advices indicate that the yield of dry wines is in the neighborhood of 8,000,000 gallons, as against 27,000,000 last year. Sweet wines will show about one-half the production of last year."

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